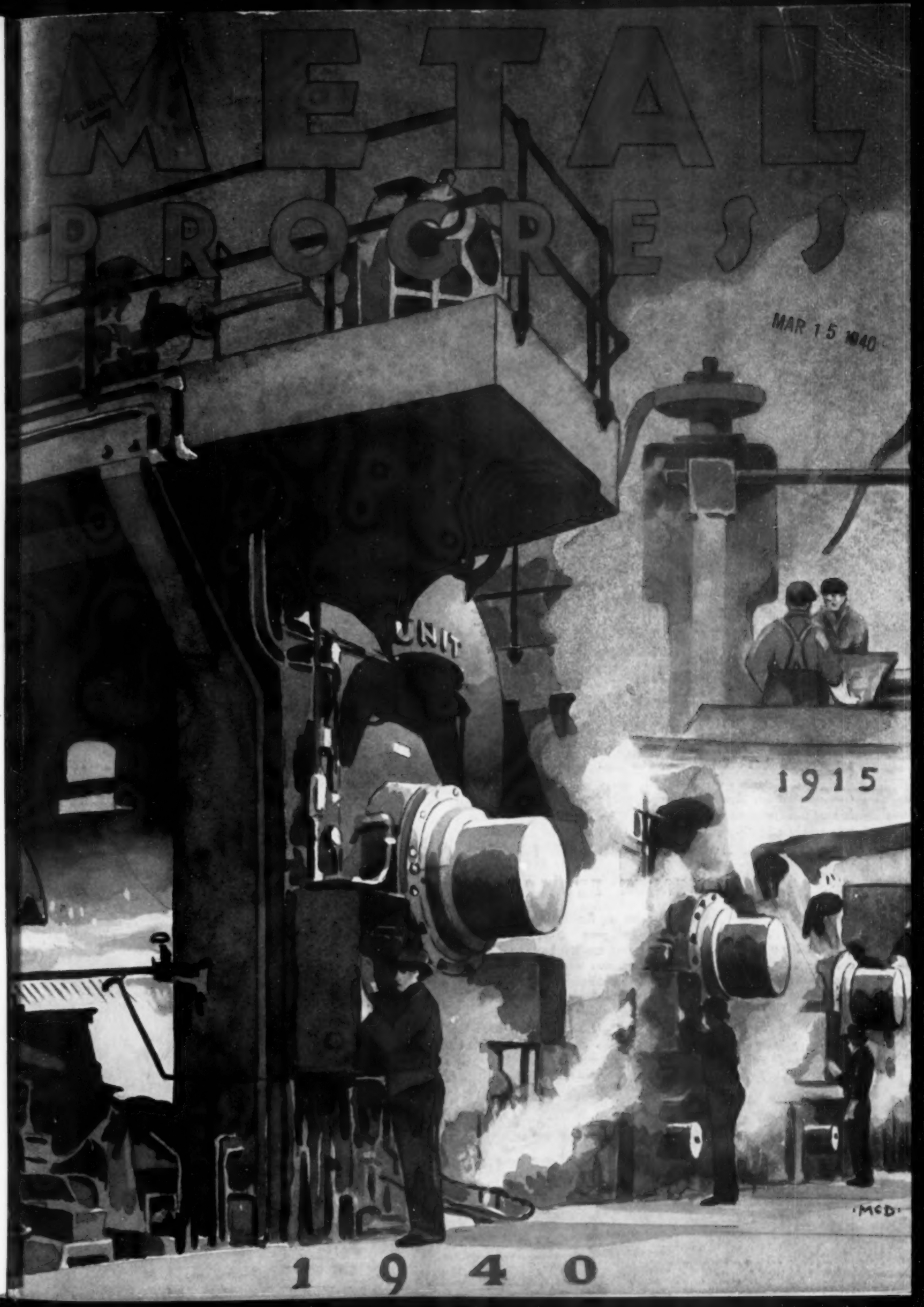
METAL PROGRESS

MAR 15 1940



FOR 33 YEARS...

Wherever HEAT Is Used In Industry . . . (SC) Developments Have Saved User's Dollars

● In the early 1900's the process of surface combustion . . . that is, combustion without flame, was first demonstrated. Those witnessing this historical demonstration foresaw the necessity of accurate control of the gas-air mixture if the full benefit were to be made available to industry. They immediately set to work and developed the automatic proportioning control, an achievement which was awarded the Edward Longstreet Medal of Merit by the Franklin Institute of Philadelphia.

RESEARCH DEVELOPMENTS

From this small but eventful beginning Surface Combustion has in cooperation with industry pioneered many new developments. While it is hard to single out the most unusual ones that the 33 years of cooperation have produced, the following are typical: The automatic inspirator for high and low pressure gas, diffusion combustion, the gas-fired radiant tube, Eutectrol gas carburizing, convection heated furnaces, atmosphere malleableizing, annealing, and hardening, the walking beam conveyor furnace, and the Char-Mo furnace for high speed steels . . . All have played their part in saving money and improving plant efficiency wherever heat is used in industry.

WHEREVER HEAT IS USED IN INDUSTRY

SURFACE COMBUSTION CORPORATION • Toledo, Ohio

SURFACE (SC) COMBUSTION

33 YEARS

MANUFACTURERS OF INDUSTRIAL FURNACES • JANITROL GAS-FIRED SPACE HEATING EQUIPMENT • AND KATHABAR AIR CONDITIONING SYSTEMS

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Consider Labor Costs When Buying Steel

On most jobs, shop labor costs are the biggest single factor—and they depend to a large degree on the steel used. If bars are too hard for bending or forming—or have hard spots to break or dull tools—if some shapes are not straight—or if in the case of alloy steel the required properties are not developed by the first heat treatment—then up go costs, down go profits.

Purchasing steel that is uniform and has the properties most desirable for your particular use often pays big dividends in the form of decreased shop costs. You do not have to pay any more for this kind of steel—so why not get it?

For several years Ryerson has been building up stocks of these better, more uniform steels. Careful selection, checking, testing and inspecting assure the uniform high quality necessary for Ryerson Certification. Try Ryerson Certified Steels on your hardest job—and check the labor costs. Many have told us that it pays.

RYERSON *Certified* **STEELS**

Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

RYERSON CERTIFIED STEELS

Principal products in stock for Immediate Shipment include—Bars, Structurals, Shafting, Plates, Alloy Steel, Tool Steel, Spring Steel, Iron and Steel Sheets, Stainless, Babbitt, Strip Steel, Welding Rod, Tubing, etc.

METAL PROGRESS

Vol. 37 March, 1940 No. 3

20 YEARS OF GROWTH

IN 1920 two groups of steel treaters, one heading up to Detroit and one heading up to Chicago, voted to join hands and so the American Society for Steel Treating (now the American Society for Metals) was formed. The Society now takes justifiable pride in its growth from small beginnings, and on reaching this first generation in its history, its President took occasion to send the telegram below to the chief executives of a group of American firms — metal producers, representatives of important metal consuming industries, and firms manufacturing equipment for the testing, treating and fabricating of metals. Response was instant and generous. The replies, arranged in alphabetical order by signatures, are printed on the following pages. Their common note is one of pride in their contributions to a fuller life for Americans.

Postal Telegraph

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TELEGRAMS

ALL AMERICA CABLES

COMMERCIAL CABLES

SINCE OUR NATION'S WELFARE AND SAFETY REQUIRES CONTINUAL ADVANCE IN THE METAL AND ASSOCIATED INDUSTRIES. AMERICAN SOCIETY FOR METALS ON ITS 20TH BIRTHDAY VIEWS WITH PRIDE ITS PART AND THE PART PLAYED BY ITS IMMEDIATE PROGENITORS IN THIS ADVANCE THROUGH DISSEMINATION OF INFORMATION TO 11000 MEMBERS EVERYWHERE. AIDED BY NUMEROUS EXPERTS WE ARE PREPARING AN ACCOUNT OF TECHNICAL PROGRESS DURING THESE 25 YEARS. PLEASE COOPERATE IN FORMULATING A STATEMENT OF SOME OF THE SIGNIFICANT ACCOMPLISHMENTS OF YOUR OWN COMPANY DURING THE QUARTER CENTURY. AND WIRE COLLECT A STATEMENT OF 100 WORDS OR MORE SUMMARIZING THEIR ECONOMIC AND SOCIAL IMPORTANCE. WITH PERMISSION TO INCLUDE IT IN OUR ANNIVERSARY PUBLICATION=

JAMES PRESLEY GILL

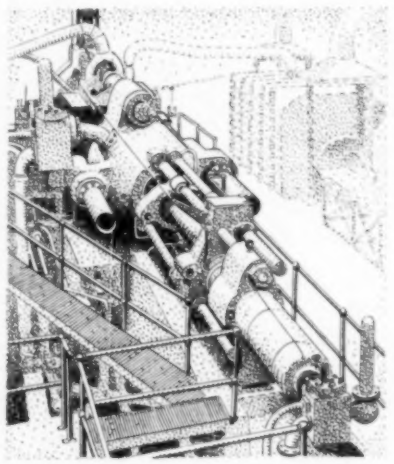
PRESIDENT. AMERICAN SOCIETY FOR METALS.

PROGRESS

In Copper and Its Alloys

WATERBURY, CONN. — Progress and development in the Copper and Brass Industry have kept pace with technical accomplishments of the past quarter century in other metal producing and working industries.

The American Brass Co. was the first to introduce laboratories for technical control and scientific study of copper and its alloys. These extended research activities have made available copper and copper alloys of finer quality and superior properties which have had great social and economic importance in the general progress of the present century. The production of copper wire of high purity with consequent high electrical conductivity has been indispensable to the development of the electric power and light industry, and of all communication systems.



The perfection of brass and copper pipe and fittings has contributed to the development and comfort of modern homes. Improved practices in production of condenser tubes, such as the extrusion and rolling process first introduced by The American Brass Co., have assisted materially in increasing the efficiency and the economy of operation of all modern types of steam generating equipment.

The discovery and development of copper alloys of high strength have been of major importance. In particular, the development of the silicon-copper alloys — such as "Everdur", having relatively high strength combined with excellent corrosion resistance — first attracted attention to the broad possibilities of copper alloys as a structural material in engineering work, and gave first impetus to the development of numerous other engineering alloys.

Many of these developments have been possible only through refinements and improvements in melting, casting and rolling equipment.

Progress is dependent on research and development. The dissemination of new technical knowledge through such societies as the American Society for Metals is of great importance and value to the industry.

THE AMERICAN BRASS CO.

PROGRESS

In Special Steels

WATERVLIET, N. Y. — The keynote of Allegheny Ludlum's technical progress in the past quarter century has been that of exacting cooperation with the requirements of other great industries for new steels necessary to make technological advances in their fields. We notably emphasize our contributions to the development of stainless steels and their extensive application to our economic life; the perfecting of a ductile chromium-aluminum alloy of high electric resistance; chromium-iron and nickel-cobalt steels with expansion matching glass for glass-to-metal seals for the electrical and radio industries; high tensile, ductile stainless alloys for airplane and railway equipment; a special copper coated strip uniformly suitable for hydrogen brazing; improvements in magnetic materials including iron-nickel and iron-nickel-copper-chromium alloys, as well as cold rolled silicon steel strip having special magnetic characteristics; the discovery and development of Silcrome valve steels for sustained automobile and airplane motor performance; the development of Nitralloy for precision machinery; the improvement in high speed toolsteel performance by substituting for a substantial portion of the tungsten a lesser percentage of domestic molybdenum, thus increasing per formance and conserving America's limited domestic deposits of tungsten; Pluramelt, making available multiple analyses in a single piece of metal, marking, in our opinion, the inauguration of a vast new field of metallurgy for the benefit of all industry and through it for the American public.

H. G. BATCHELLER
President, Allegheny Ludlum Steel Corp.

PROGRESS

In Heavy Machinery

HARRISON, N. J. — During the century of its existence, the Worthington Pump and Machinery Corp. has, we believe, contributed substan-

tially to the whole nation's welfare through a consistent improvement in the economical performance of the equipment which it manufactures. While a considerable portion of the knowledge which has made this contribution possible has naturally been developed within our own organization, nevertheless much has been acquired through the activities of the various technical societies. In the field of materials, this latter applies particularly to the American Society for Metals, and its associated activities, notably the publication METAL PROGRESS. Perhaps the outstanding improvement in the application of metals to pumps and compressors for a great variety of service conditions during the period of your existence has been the development of the high test cast irons, in our particular case "Wompco Metal", and the numerous corrosion resisting alloys such as our "Worthite Metal". Of equal importance stands the tremendous advancement made in the scientific processing and heat treating of nearly all metals which enter into the construction of all classes of heavy machinery. The growth of many of the country's great industries, such as the petroleum and chemical, has unquestionably been accelerated by these developments.

We salute you on your twentieth birthday.

H. C. BEAVER
President, Worthington Pump and Machinery Corp.

PROGRESS
In Telephonic Materials

NEW YORK CITY — Important technological developments made by the Bell System tending toward economy in metallic materials and of social significance during the past 25 years may be listed as follows:

1. Improved magnetic materials, known as the "Permalloys", "Perminvars", "Permendurs" and "Remalloy", have made possible economies in transmission and in switching and have advanced the telephone art. Permalloys are utilized in quick acting relays, transformers, in continuous loading of submarine telegraph cable, and in compressed powder cores in loading coils on long-line circuits. Perminvars are used where constancy of permeability and extremely low hysteresis losses are essential. Permendurs are highly permeable at high flux density and are employed as receiver diaphragms in the new types of telephone handsets. Remalloy, a superior permanent magnet material, is also utilized in the handset receiver.

2. Dispersion hardened antimony and calcium alloys of lead have been developed for sheathing cables and have been a factor in the extended use of cables. Circuits so encased are less subject to environmental conditions than are open wire circuits.

3. An improved wiping solder consisting of lead-tin-arsenic has been developed for joining cables.

4. Precious and base metal contacts have been developed that assure dependable telephone communication.

5. The vacuum tube is among the developments which have made possible the high quality long distance telephone transmission which we have today. It involves new metallic materials for its filament and other elements. A life span of 30,000 hr. is realized in Bell System service. The copper to glass seal which was perfected during this period has been especially important in advancing radio transmission.

6. A new storage battery grid material, a lead-calcium alloy which affords longer service life accompanied by power savings, has been developed.

FRANK BALDWIN JEWETT
Vice-President,
American Telephone & Telegraph Co.

PROGRESS
In Toolsteels

READING, PA. — We salute the American Society for Metals on its 20th birthday as a technical organization whose efforts have been devoted to training men in the metal-working and metal-producing industries that they might better cope with their problems. During the 25 years or more of the present Society and its predecessors, the individual members have witnessed many metallurgical developments to which The Carpenter Steel Co. has made liberal contribution — including the first free-machining stainless steel, the first stocks of "acid tested" toolsteel, the first "limbre controlled" toolsteel, the first practical impact test for hardened toolsteel, the first extensive commercial development of ductile, bright-finished stainless strip steel, and the first "Matched Toolsteels". To these should be added the Company's pioneering achievements in welded stainless

tubing, and special alloy steels for electrical and magnetic purposes. For 50 years The Carpenter Steel Co. has served the metal-working industry wherever and whenever extraordinary steels and alloys are required to realize a new product or improve an old one. Through its skill in the manufacture and application of metals, and its policy of disseminating helpful information, we believe the Company has made important contributions to the development of the automobile, machine tool, pneumatic tool, aircraft, oil, electrical, and many other modern industries. High among these contributions has been its leadership in "tooling up" industry for mass production.

F. A. Bigelow
President, The Carpenter Steel Co.

PROGRESS

In High Strength Steel

Chicago — The principal achievements of the Inland Steel Co. during the last 20 years have been two-fold. First, the pioneering and improvement in the manufacture of sheets and strip through the building of two continuous hot strip mills that raise the quality and increase the tonnage of this product. Second, the creation of two new alloys; Inland Hi-Steel, the high strength, low alloy with twice the tensile strength of carbon steel, improves operating efficiency of mobile equipment by eliminating dead weight and greatly increasing the payload; Inland Ledloy, the new lead-bearing openhearth steel with tremendously improved machinability, maintaining all the good structural and heat treating properties of carbon steel, reduces the cost of machined parts which in turn is a factor in lower costs of finished products to the consumer.

P. D. Block
President, Inland Steel Co.

PROGRESS

In Casehardening Salts and Compounds

Detroit — Park Chemical Co. started operations on 625 sq.ft. of floor space at about the same time the Steel Treating Research Club of Detroit, predecessor to American Society for Metals, was organized. Today we utilize about 68,000 sq.ft. for manufacturing everything for hardening, heat treating and finishing steel. Our first product was one type of casehardening compound. Through the various years we have developed other types of compound for pack hardening, and the newest is a compound of the non-burning type, entirely different in that it is the lightest material ever produced and utilizes as energizing medium only barium carbonate. This type of material advances the casehardening operation by permitting such operations as quenching direct from the carburizing boxes without loss of compound due to burning.

Years ago pure sodium cyanide was used for hardening. This company at various times has developed many different cyanide mixtures, which improve the results, as well as reduce the costs. The use of cyanide mixtures, as well as some pack-hardening operations, has been greatly improved by the recent introduction of liquid carburizers (which in a sense are activated cyanides) for the production of light cases. Another innovation, which has been accomplished by this company, is the introduction of neutral salt baths as heating mediums in hardening and heat treating operations. On many grades and types of work this method offers distinct advantages over the use of lead pots or hearth-type furnaces. It has also permitted the greater use of internal-electrodes for electric heating. Another important procedure is the use of salt bath mixtures for the hardening of high speed steels in pre-heat, high-heat and quenching salts. Furthermore, some high speed tools are greatly improved in efficiency if they are given a slight nitriding or casing treatment.

The dissemination of information by the American Society for Metals, as well as the benefits resulting from the general activities of the Society, we believe, have contributed much to our progress.

J. N. Bourg
Vice-President, Park Chemical Co.

PROGRESS

In Locomotive Performance

Philadelphia, Pa. — Refinements in steam locomotive design over past 25 years have been greatly aided by development through metallurgical advances of materials which permit greater stresses without increasing dimensions and which reduce maintenance in service. Efficiency of engines has been greatly increased

due to use of the feed water heater, the automatic stoker, the improved superheater, high steam pressures and roller bearings. The foregoing, plus improved manufacturing processes and lubrication methods, have made steam locomotives mechanically more reliable in service. Introduction of diesel electric switching locomotives has given railroads the opportunity for improved economies.

Other products of our company which have been notably improved include large brass castings such as ship propellers made by Rand-Upson molding process, which produces smooth unblemished castings of greater accuracy than heretofore possible.

Extending the scope of its manufacturing processes, our Baldwin-Southwark Division has made distinct improvements in hydraulic presses and has developed testing machines up to 4,000,000-lb. capacity and high precision to meet modern requirements.

CHARLES E. BRINLEY
President, The Baldwin Locomotive Works

PROGRESS

In Instruments for Process Control

WATERBURY, CONN. — During the past 25 years The Bristol Co. has played an extremely important part in advancing the art of industrial process control by means of instruments. Many major automatic control developments have been perfected for use in holding industrial process variables at the exact value known to produce the desired results. These instruments have contributed greatly to improving the quality and uniformity of products; in addition they have helped to reduce manufacturing costs by facilitating production, saving time, and eliminating rejections. A few of the more important Bristol instrument developments are as follows: The Pyromaster Potentiometer Pyrometer Controller in its many forms (this controller, because of its high accuracy and more rugged construction, has extended the use of the potentiometer into new fields particularly in the metal industry); the Process Cycle Controller for automatically controlling mechanical operations; the Metameter System of Telemetering for temperature, pressure, flow, liquid level, voltage, current, power, and totalized power load (this has reduced telemetering to a practical and widely used method of gathering information at a central point); the Bristol pH Controller in its modern rugged form for plant use; and Bristol's System of Coordinated Process Control for automatically operating and controlling all of the phases of a process that affect quality of final product.

H. H. BRISTOL
President, The Bristol Co.

PROGRESS

In Electrical Equipment

PITTSBURGH PA. — Significant, to us, of the past 25 years' achievements in advancing industry's ability to serve, is the fact that developments of electrical engineers are quickly applied to production processes of all other industries, thus providing these with sufficient power for their continually increasing requirements and with refinements in control that permit working to extreme precision limits. Many of these electrical developments were made possible by the new use of new metals and of new metal fabrication processes.

Among the contributions of Westinghouse in the past 25 years have been 3600-r.p.m. steam turbine generators up to 81,500 kva. in capacity, operating so efficiently they require but one pound of coal for one kilowatt produced; water power generators rated up to 108,000 kw.; power and control equipment for modern steel mills soon to be speeded at 2300 ft. per min. for strip; 5000-hp. 100 mile-an-hour electric locomotives for rail electrification and electric equipment for the streamlined diesels; lightning-proof transmission lines up to 287,000 volts; refinements in welding; more accurate meters and measuring instruments, photocells and similar electronic tubes to give industry precision in manufacture; even the cleaning of air of harsh particles when so required; improvements in illumination including a host of gaseous vapor lamps; even radio broadcasting so that industry may disseminate information about its products to the general public while it catches their attention with entertainment.

These are, of course, but a few of the major items provided by an electrical manufacturer. Details of products now available for industry would require a listing running into thousands.

G. H. BUCHER
President, Westinghouse Electric & Mfg. Co.

PROGRESS

In Metal Processing Aids

PHILADELPHIA — Your 20th Anniversary, our 75th! During this period Houghton has contributed to the development of the metal industries in many ways, first of all by publications such as "Steel Treatment" and "Practical Metallurgy for Engineers", the latter still being used as a textbook in many universities. Second by the development of a technical staff for servicing the processing of metal by the development and perfection of scientific substitutes for staples — such as modern quenching oils for fish oils, prepared carburizers in place of raw bone, sulphurized cutting oils to replace lard oils — by the perfection of liquid salt baths for heat treatment, the origination and development of liquid carburizers and the development of an anti-pipe compound to increase the ingot yield in steel making with no carbon pick-up.

A. E. CARPENTER
President, E. F. Houghton & Co.

PROGRESS

In Induction Melting

PHILADELPHIA — Significant accomplishments of Ajax Electrothermic Corp. and its associated companies are as follows: One, development of the Ajax-Wyatt submerged resistor induction furnace which has replaced almost 100% of the melting equipment previously used in brass mills of this country and at least 75% in foreign countries. Nearly 1000 furnaces have been installed and have almost completely revolutionized the brass mill melting practice. Two, development of the Ajax-Northrup high frequency induction furnace. This equipment was rapidly adopted throughout the world for melting high alloy steels, and has been the means of developing alloys of such high importance as Permalloy and Alnico. Its use for surface and zone hardening and zone heating is being rapidly extended. Three, the development of the Ajax-Hultgren salt bath furnace for liquid carburizing, annealing, brazing, tool hardening, and other heat treating operations.

G. H. CLAMER
President, The Ajax Metal Co.

PROGRESS

In Toolsteel Manufacture

CHICAGO HEIGHTS, ILL. — Our records show that during the last 25 years, we Americans helped win a real war and then readjusted and made a substantial contribution to the greatest period of prosperity this country or the world has ever known. In the last ten years, we have seemingly faced never-ending difficulties but have managed somehow to keep our part of the world going. During all this time, toolsteels have had an essential part in producing some 50,000,000 automobiles, helped keep the railroads rolling and helped produce plenty of agricultural machinery; they had a part in making millions of iceless ice boxes, to say nothing of billions of tin cans and gadgets from ball bearings to brassiere buckles. Columbia Tool Steel Co. has used more iron, scrap, alloys, coal, gas, oil, machinery, equipment and instruments than we can count and thanks largely to the A.S.M. boys, reached new highs in the improvement and control of product and the better use of raw materials. Completely new and better methods of manufacturing our products, from the selection of raw materials to the preparation of the steel for shipment, have come during this period. In addition we have acquired a "twice as good" technique in servicing our product in the field.

ARTHUR T. CLARAGE
President, Columbia Tool Steel Co.

PROGRESS

In X-Ray Apparatus

CHICAGO — While industrial scientists have made magnificent advances in development of new materials and new uses for the products of their research, contributions of X-ray engineers have been in two major categories: *(a)* More powerful, more efficient apparatus and improved techniques for radiographic inspection of welds and castings — that strength and

safety may be assured without resorting to excess cost and weight of metal parts, and *(b)* simpler, more economical apparatus and methods for research and study by X-ray diffraction —to provide means for determining the suitability of metals for their intended uses, to direct improvements in metal working and treating, and to guide the development of new metals and alloys to fulfill a variety of human needs.

J. H. Clough
President, General Electric X-Ray Corp.

PROGRESS
In Twist Drills and Reamers

Cleveland, Ohio — The improvement in metal cutting tools such as twist drills and reamers in the past 25 years has contributed greatly to the remarkable advances in the metal working industries, and The Cleveland Twist Drill Co. has taken a leading part in research for the development of new and better tools.

The "Peerless High Speed Reamer", in which high speed blades are brazed into a soft steel body, made high speed reamers available to a new field of usefulness. The "Cleforge High Speed Drill" has set a new standard for toughness, wearing quality and accuracy. Twist drills made of high speed steel smaller in size than No. 60 were introduced. The "Ezyout Screw Extractor" provided a new tool to fill a long-felt want. Tougher and sturdier end mills, counterbores and adjustable reamers have led to a higher degree of usefulness. Improvement of the so-called carbon steel tools by small amounts of alloy and better heat treatments has retained for them a definite economic field.

The early part of this quarter century, particularly during the World War, witnessed the general acceptance of the 18-4-1 type of high speed steel. The last five or six years has seen the introduction by our company of the "Mo-Max" molybdenum-tungsten type of high speed steel, 18-4-1's first serious competitor. The improved quality of "Mo-Max" has resulted in its adoption for a substantial proportion of the high speed tools of the country. In addition to its high quality and low cost, it is particularly valuable because of its great strategic importance, requiring for its manufacture a maximum of domestic and a minimum of imported raw materials.

J. D. Cox
President, The Cleveland Twist Drill Co.

PROGRESS
In Specialty Steels

New York City — A most significant accomplishment of the Crucible Steel Co. of America is the extent and completeness of the types of specialty steels developed and produced to meet and anticipate all industrial needs. "Rex" high speed steels are available in all commercial variations for specific applications. Noteworthy also are the "Rezistals", corrosion and heat resisting steels for varied industries, particularly chemical and food. To these should be added aircraft-quality alloy steels which, among many other applications, are making modern transportation faster, safer and less costly. Another achievement is "Rexalloy", a new cutting tool material, cast to shape, which increases production and lowers unit tool costs. Spectacular are "Alnico" permanent magnets, the most powerful ever developed, and which are now revolutionizing radio loud speakers. But I repeat, the most significant accomplishment is the fact that Crucible makes every type of specialty steel that American industry uses to produce more economical and better products for the well-being of American citizens.

R. E. Desvernine
President, Crucible Steel Co. of America

PROGRESS
In Magnesium and Its Alloys

Midland, Mich. — 1940 marks the 25th anniversary of the commercial production of magnesium metal in the United States. In 1915 The Dow Chemical Co. pioneered in this field by developing an original process for extracting the light weight metal from mineral deposits. During the past quarter century Dow has perfected several alloys of magnesium to give it structural strength, and is continuing to cooperate with manufacturers in engineering the material into their products wherever weight reduction is essential. These alloys, marketed under the trade-name "Dowmetal", are made into the usual metal forms and their lightness and strength have won them widespread application in the entire field of transportation, especially in the construction of aircraft parts. Engine housing castings and wheels made of magnesium alloys, for example, have now

become accepted standard equipment. Dowmetal is also extensively employed for many other industrial uses such as portable tools and instruments, light weight machinery conveyors, and safety blocks for presses.

WILLARD H. DOW
President, The Dow Chemical Co.

PROGRESS
In Heat Resistant Castings

HARRISON, N. J. — Exactly 25 years ago Driver-Harris Co. conceived the idea of making nickel-chromium heat resistant castings to supplement its manufacture of electrical resistance wire. The idea was novel but was readily accepted by members of your young Society in industries where casehardening of metals was essential. Thus greater economy and expeditious processes in the automotive industries as well as other vital industries were effected. In June 1939 the 16,000,000th pound was manufactured, concurrently with research and development on longevity of electric furnace element wire to withstand high temperatures under gruelling conditions. Heat resistant alloy has been correspondingly improved to meet the imperative demands of modern engineers. Many designs, shapes and forms to facilitate manufacturing processes have been evolved during the quarter century.

FRANK L. DRIVER
President, Driver-Harris Co.

PROGRESS
In Protective Finishes

WILMINGTON, DEL. — Referring to your telegram, the following is a summary of five du Pont developments importantly significant to metal and associated industries: 1. Development of Duco cellulose nitrate lacquers, resulting in large savings to the automobile industry through reduction of painting cycle from 12 days to one day, and great benefits to the public through extending the life of such finishes to three to five years, as compared with life of three to five months with oleo-resinous products previously used. 2. Development of Dulux alkyd resin enamels, including a high bake white enamel having the appearance of porcelain, which retains its luster and whiteness and which has been used on five to six million refrigerators in the past 10 years. 3. Development of du Pont carburizing salt, which gave the casehardening industry a new, efficient and stable composition for producing deep carbon cases at the usual carburizing temperature. 4. Development of high speed copper plating from cyanide solutions resulting in increased efficiencies and brighter, smoother deposits. This is of great significance in the sequence of copper-nickel-chromium plating used by automotive hardware manufacturers. 5. Development of a bright zinc plating process, resulting in brighter, more ductile deposits and increased efficiencies — a process substituting ably for cadmium plating.

LAMONT DU PONT
President, E. I. du Pont de Nemours & Co., Inc.

PROGRESS
In Optical Instruments

ROCHESTER, N. Y. — Stimulated by Doctor Sauveur and other research workers as to the value of optical instruments in the metal industries, we have diligently carried on research and development for the last quarter century which has resulted in making available to the metallurgical engineering profession the highly perfected spectrograph for analysis of elements, metallographic equipment for study of microstructure of metals, and the contour projector for the accurate checking and measurement of finished parts. Significant results of these developments are the accumulated knowledge of the behavior of metals and their physical properties.

M. H. EISENHART
President, Bausch & Lomb Optical Co.

PROGRESS

In High Strength Gray Iron

BOSTON — Previous to the last quarter century, the foundry industry was largely directed and operated by the practical foundryman. Isolated exceptions were found where the skilled inventive ability and personal attributes of some one man made him and his company outstanding in the foundry industry. Men of this type were Alger of our predecessor company, inventor of the air furnace for the melting of gray iron in the years 1809 to 1828, and Hunt who, during the years from 1861 to 1884, developed this process to the point where the iron was used for coast defense guns because of its exceptionally high physical properties. This iron was later adopted for the cylinder and valve parts of locomotives operated at higher speeds and on longer runs which were then being converted to the use of superheated steam.

The last quarter century has seen a widespread employment of scientists, metallurgists and engineers in the foundry industry, by which the level of quality of its product has been raised far above that of the earlier foundries. Hunt-Spiller Mfg. Corp. was a pioneer in the introduction of metallurgical control and research in the foundry. This company early recognized the need for irons of unusual characteristics for special industrial applications where the properties of resistance to corrosion and heat, low or high coefficient of expansion, and high strengths were essential. An original and outstanding development was the use of Hunt-Spiller Air Furnace Gun Iron for truck and bus brake drums which had previously been made of material that had failed to meet the demands of modern automotive transportation. This organization was also among the first to perform fundamental research in connection with the reclamation, conservation, and control of molding sands.

VICTOR W. ELLET
President, Hunt-Spiller Mfg. Corp.

PROGRESS

In the Forging Industry

CHICAGO — During the lifetime of your Society our company pioneered and developed molybdenum steels for die blocks, hammers, and forging machine parts used in the drop forging industry. The molybdenum-chromium-nickel type of alloy steel that has become the standard die steel of the drop forge industry was invented by Wm. Finkl. This company also introduced and perfected the full-quenched, heat treated die blocks that are recut two to three times the amount previous partial-quenched die blocks were. The present molybdenum-chromium-nickel die block has contributed greatly to economics during the past two decades by reducing die costs and increasing production of parts for the automotive, farm implement and transportation industries of our nation. Production per die has continually increased despite the reduced tolerances and finer finish and balance required in drop forgings today.

A new development of the past two years is the family of alloy steels containing copper in addition to molybdenum, chromium and nickel. They are very "deep hardening", having the same strength and hardness throughout even in sections 16 in. thick. This steel has already shown very excellent results as die blocks. Just what greater importance uniform strength throughout machinery parts will mean to the engineering world, the future will tell, but judging from past developments of engineering materials it should be important.

May we congratulate the American Society for Metals on 20 years of continuous service to the metal and associated interests and to its members? The Society and the service it has given the nation and world are tops without equal.

WILLIAM FINKL
President, A. Finkl & Sons Co.

PROGRESS

In Oil Well Drilling Tools

HOUSTON, TEX. — Congratulations to the American Society for Metals on your 20th birthday and compliments on the importance of your part in the remarkable progress of the metal producing, treating, and consuming industries. The multifold improvement in the performance of oil well drilling tools — made possible by the advancement of knowledge and of technique in the manufacture, treatment, and application of metals and metal products sponsored by your leadership — has enabled the oil industry to drill to recent record depths in excess of 15,000

ft. as compared with the record depths of 25 years ago approximating but 6000 ft. Problems of handling increased unit loads on drilling bits and other drill stem members resulting from modern methods of drilling, coupled with generally smaller well bores and higher rotary speeds in the urge to reduce drilling costs, have been successfully met with the enhanced physical properties obtainable through the use of specialized metals and metal processes.

H. W. Fletcher
Vice-President and General Manager
Hughes Tool Co.

PROGRESS
In Automotive Transportation

Dearborn, Mich. — My congratulations to the American Society for Metals on its 20th birthday. Improvement in metals, their manufacture and processing, has played a considerable part in the high quality of automotive transportation available today. Our Company, we are glad to say, has played a rather significant part in this improvement. In 1907 we started pioneering with alloy steels, and followed by developing welding processes and welded designs with their necessary equipment. We then introduced rustless steel into mass production, developed new alloys and new methods for casting, heating, upsetting, forging and hardening. New designs and products have been made possible by the above developments, while lower material and processing costs have resulted in greater employment and more value for the consumer.

Edsel B. Ford
President, Ford Motor Co.

PROGRESS
In Sound Steel Ingots

Baltimore, Md. — While experimental big-end-up molds had been demonstrated, no steel producer was willing to admit that they would ever be practical to handle in commercial tonnage production. However, early in 1915, exactly 25 years ago, an openhearth superintendent who is now a top executive in the steel industry, telephoned us to help him in an order of 100,000 tons of steel for high explosive projectiles. Big-end-up molds increased yields from about 25% (which this plant had been getting into finished shells) to approximately 70%.

The result was that practically all of the ordnance produced in America during the balance of the World War was produced in Gathmann big-end-up molds. Today the same situation exists, and almost every producer of sound steel uses this type of mold for at least part of his output. The social importance of this method for improving the yield of sound steel would be impossible to calculate, because the greatest of the benefits accruing have been intangible. We can't conceive of present living conditions without them. In transportation alone — in the air, on land and water — the speed we accept as normal today would be impossible except for the fact that we can and do produce sound steels. The economic value? Again an estimate is impossible, because there is no way of determining the quantity of valuable alloys that would have been lost in the remelting of scrap, or the loss of iron that has been avoided by smaller ingot crops. Looking back, it's difficult to realize that steel producers used to say they weren't very much concerned about yields. (Didn't they have to have a certain percentage of scrap to make their heats?) Today, steel men as a body readily admit what few would then believe, that steel products are no sounder or more trustworthy than the ingot from which they were rolled or forged.

Emil Gathmann
President, The Gathmann Engineering Co.

PROGRESS
In Accuracy and Finish of Machined Surfaces

Cincinnati — The past quarter-century has been a momentous period in the machine tool industry and for our company. Much of our activity has centered around the development of the automatic milling machine, the centerless grinder, the surface broaching machine, the automatic profiling machine, and the widespread use of hydraulic mechanisms. The productivity of our product has been greatly increased, and refinement of accuracy and finish are now available to limits far beyond the conception of 1915. These developments contribute greatly to producing more and better goods for more people at lower cost.

Research work and the exchange of ideas by engineers through technical societies like yours assures continued progress. We salute the American Society for Metals on its 20th anniversary and send our best wishes for its continued success.

FREDERICK V. GEIER
President, Cincinnati Milling Machine Co.

PROGRESS

In the Tonnage Steels

BETHLEHEM, PA. — One of the most outstanding developments in the steel industry to which all of the major sheet producers have contributed in the past 25 years has been the development of high quality, deep drawn steel sheets, which have made possible the fender and the all-steel top of the modern automobile. Each of the major steel companies has developed and placed on the market a commercial steel having high resistance to atmospheric corrosion and high tensile strength, thus permitting substantial savings in weight in structures where atmospheric corrosion is a major factor. Bethlehem Steel Co., either alone or in collaboration with others, has made the following developments: Apparatus for rapid determination of resistance of commercial steels to atmospheric corrosion, which permits in a period of three months the prediction of the relative resistance of such steels at the end of many years' exposure to the atmosphere; development and promotion of wide flange structural beams, with resulting increased strength of shapes with less overall weight; similar development and promotion of sheet piling in structural sections, leading to increased use of steel in marine structures and foundations; the Bethanizing Process for electrolytically coating wire with zinc was experimentally developed and is a commercial reality; the process of controlled cooling of rails, which process has been made available to all rail manufacturers in the United States and which gives almost complete assurance against an extremely dangerous type of rail failure known as the transverse fissure, heretofore frequently encountered in service.

E. G. GRACE
President, Bethlehem Steel Co.

PROGRESS

In Industrial Gas Applications

CHICAGO, ILL. — Peoples Gas, Light and Coke Co. has, in common with progressive firms in the American Gas Association, long recognized the importance of the metal industries in building up an important volume of sales. Since 1921 we have maintained an active and well organized Metallurgical Research Laboratory. In that time it has developed furnace atmosphere control with use of reformed city gases, and an entirely new fundamental furnace design for bright annealing, carburizing and controlled decarburizing, which lowers costs by decreasing scale and decarburization losses. It has developed means for the practical perfection of the first economical and satisfactory generator of metallurgical nitrogen from air and combustibles. It has invented a more flexible and economical process of making permanent magnet metals. The laboratory has also recently developed and perfected the design and supervised the construction of 25 to 30 large industrial installations of high temperature (2300 to 2400° F.) gas-fired forging and billet furnaces, resulting in 75% less scale and 66⅔% less decarburization than heretofore possible with a non-muffle furnace, or open combustion in a heating chamber. Our Metallurgical Research Laboratory has also made notable contributions to the science of metals, such as the development of the paraffin disk method of sample preparation, which saves 90% of preparation labor on research quality samples, and makes possible more interpretable and reliable enlargements up to 5000 diameters than were previously obtainable at 200 diameters. It also established an international record for highest direct magnification of metal. We therefore have continuously encouraged a large number of our employees to maintain membership and extensive participation in the American Society for Metals since its inception.

R. B. HARPER
Vice-President, Peoples Gas, Light & Coke Co.

PROGRESS

In Corrosion Resistant Alloys

BOSTON — The principal contribution of heat resisting alloys during the quarter century is the making possible of modern furnaces and the mechanizing of heat treatments to keep pace with machine production. This is an essential for low priced modern automobiles, insuring human life through precision metallurgical processes, quartering the cost and quadrupling the service of working metal parts generally.

Modern furnaces heat treat metal without heat treating the steel treaters; they improve working conditions, reduce accidents, make more metal parts to make more automobiles, to make more jobs and wages, to buy more automobiles. Anything from knitting needles to a clap of thunder is now heat treated mechanically! Industries could better pay $10 per lb. for all Q-alloy and X-ite in service than do without heat resisting alloys. Corrosion resistant alloy field is making terrific strides, simplifying and economizing the handling in process industries, making possible new processes, new safety, new product, new jobs as well as safer milk, stronger thread, brighter colors, slicker grease, hoppier beer, better battleships, and cooler stoves.

H. H. HARRIS
President, General Alloys Co.

PROGRESS

In Forged Crankshafts

HARVEY, ILL. — Twenty years have shown remarkable progress in crankshaft forging. Crankshafts are now designed to overcome fatigue and wear, to eliminate unnecessary material and to facilitate dynamic balance. Integral counterweights are now generally used. Machining has been reduced to a minimum. By careful selection of steel, laboratory control and modern heat treating furnaces the most exacting requirements can now be met. Practically none of these things could be done 20 years ago and the result is that a far better and less costly crankshaft is now being made than was possible in 1920. Even greater progress should be shown in the next 20 years.

SAMUEL M. HAVENS
Vice-President, Wyman Gordon Co.

PROGRESS

In Tractors and Road Machines

PEORIA, ILL. — The past quarter century has witnessed tremendous advances in our industry through the employment of improved metals and better tools, thus permitting great developments in design. Today's tractors have notably increased mobility and versatility, more pull per pound of weight, faster travel, wider speed range, easier operation and better performance in every respect. Today's engines have the advantage of lighter weight, greater power, more strength, longer life and particularly more economical utilization of diesel fuels. Today's road machines serve users and public alike by building and maintaining vastly increased mileages of road for fewer taxpayers' dollars. Society can thank engineers for refusing to accept popular notion that limits of opportunities for progress have been reached.

B. C. HEACOCK
President, Caterpillar Tractor Co.

PROGRESS

In Meeting Difficult Steel Specifications

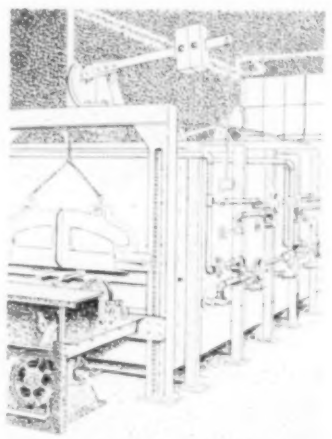
PITTSBURGH, PA. — We send congratulations to American Society for Metals on its 20th anniversary. We are proud to have participated in a small way in the development and growth of your fine Society. During past quarter century you and your predecessor groups have assisted us and all metal manufacturers and fabricators to meet adequately the increasingly difficult demands of modern rigid metallurgical specifications applied by our own and other industries. During these years much of the carbon steel sold by our Company has been replaced by alloy steel, now melted under closest supervision in our own acid openhearth and electric induction furnaces. This and many other important changes in our business have resulted in doubling the employment in the Heppenstall organization in the past 25 years. We count on further assistance from your Society, so that we may continue to improve our service to American industry.

R. B. HEPPENSTALL
President, Heppenstall Co.

PROGRESS

In Wherever Heat Is Used in Industry

TOLEDO, OHIO — At the turn of the century there occurred an event of inestimable benefit to the art of heat treating. For the first time man had succeeded in producing "flameless combustion". By premixing air and gas in proper proportions, projecting the mixture through a porous refractory diaphragm and igniting it, the mixture burned instantaneously on the surface of the diaphragm. Those witnessing this invention foresaw the necessity of accurate control. They immediately set to work and succeeded in developing the automatic proportioning control of the air-gas mixture, an achievement which was crowned by the Franklin Institute with award of the Edward Longstreet Medal of Merit. From this small beginning some 30 years ago there has been built up through unceasing research and development the Surface Combustion Corp.'s organization now serving the entire metal industry from the production of the metal to the refined heat treated and finished part. A rough brick chamber yesterday, today the modern furnace is a scientific, highly mechanized heat treating machine with accurate and automatic control of temperature, atmosphere, and all other governing factors. Surface Combustion Corp., through its research, experience, and cooperation from industry, introduced continuous gas carburizing, the alloy walking-beam furnace, the continuous convection heating furnace, the one-way fired soaking pit, Char-Mo gas atmosphere for molybdenum high speed steels, and has contributed much to the knowledge of controlled atmospheres. The portent of these efforts in the economic and social fields may be gaged by witnessing the ideal operating conditions of the modern heat treating furnace in the speed of its operation, the healthful conditions surrounding it, the easing of the burden from the operator, and its overall contribution in helping industry to make more things for more people.



H. M. HEYN
Sales Manager, Heat Treatment Division
Surface Combustion Corp.

PROGRESS

In Grinding Equipment

WORCESTER, MASS. — Norton contributions to industry include special Alundum abrasives, special bonding materials for vitrified grinding wheels, and a unique method of grinding wheel manufacture known as controlled structure which was an important step toward making grinding a science instead of an art. The Norton Diamond Grinding Wheel has been vital to the success of the cemented carbides, and the new metal bonded diamond wheel is a still further important improvement. Among Norton machine developments are production-precision grinding machines for cylindrical work, including crankshafts and auiomatic camshaft grinders and semi-automatic plunge-cut grinders. Norton lapping machines provide commercial machining processes by which refinement in surface texture and accuracy is carried beyond the limits obtainable by grinding. Other developments include high grade refractory products, stones for grinding wood into pulp for news print, porous diffuser plates for sewage disposal plants, non-slip floors. Norton boron carbide is the hardest known substance except the diamond. Invention of the electro-coating of abrasive papers and cloths by a Norton affiliate company had an important effect on the sandpaper industry. These are but a few of the inventions and developments that Norton has contributed and which have been important to industry in reducing production costs and improving production quality.

ALDUS C. HIGGINS
President, Norton Co.

PROGRESS

In Fast Machining Steels

INDIANAPOLIS, IND. — In 1934 Monarch Steel Co. discovered and has since developed two unusual steels we have called "Speedcase" and "Speedtreat". In presenting these steels we have given industry products that definitely

increase production, lower costs, and unquestionably improve quality of manufactured parts. Speedcase is a low carbon openhearth carburizing steel which machines from 50 to 100% faster than other low carbon openhearth steels. Speedtreat is a medium high carbon openhearth steel which machines from 35 to 75% faster than equivalent medium high carbon openhearth steels. In addition to machinability, the two steels have physical properties that show improvement of from 10 to 25% over equivalent steels. Customers have reported saving up to $200 per ton of steel used.

F. T. Holliday
President, Monarch Steel Co.

PROGRESS

In the Aluminum Industry

Pittsburgh — The aluminum industry, America's oldest and largest electrochemical industry, has had its growth within a half century and its important developments in strong alloys during the life of the American Society for Metals. These improvements have been important for national defense as well as industrial applications. Our slogan "Nature made aluminum light, but man has made it cheap and plentiful and strong" lays proper stress on the fact that strength through alloys has been an absolute essential to enable more people and scores of industries to enjoy the benefits of aluminum.

Roy A. Hunt
President, Aluminum Co. of America

PROGRESS

In the Rubber Industry

Akron, Ohio — Among the many Goodrich accomplishments during the past quarter century that have had a marked influence on the metal industry is the discovery of "Koroseal", a new synthetic material having high resistance to acids, alkalies, oils, water, sunshine and deteriorating agents generally. Other properties make Koroseal a superior insulation for electrical wire and cable and for plating racks and baskets used in the plating of metals, as well as for innumerable other purposes such as the treatment of fabrics for raincoats, shower curtains, draperies, table cloths and the like. The discovery of the "Vulcalock Process" of adhering rubber to metal and of the Triflex Rubber Lining for metal tanks and pipe has made possible vast improvements in the continuous pickling of metals and in the storage and shipment by railroad in rubber-lined metal tanks of practically all corrosive liquids. Goodrich developed the rubber "Flexlock Joint" for metal and ceramic pipes, making possible highly efficient, quickly assembled, flexible and economic pipe lines. There is also the development of aircraft de-icers to eliminate ice from exposed parts of aircraft during flight, making flying safer the year around. In our own industry may be cited the development of the anode process for making rubber articles directly from liquid latex as it comes from the rubber tree and for coating metals with rubber coverings; the discovery and development of the agerite anti-oxidants for rubber which greatly extend the useful life of all rubber products and made it possible to use rubber in many new services (exemplified by the manufacture of composite metal-rubber constructions such as vibration dampeners and sound deadeners for machinery which add to the comfort and efficiency of workers as well as make more efficient and comfortable the American automobile). In brief, the widespread use of these and other Goodrich developments in rubber has made possible a wider use of metal in industry and has contributed to the advance in almost every industrial field.

S. M. Jett
Secretary, B. F. Goodrich Co.

PROGRESS

In Rolling of Strip Steel

Pittsburgh — The past 20 years has seen United Engineering & Foundry Co. pioneer and develop the rolling of strip steel in continuous four-high mills. The general adoption of these methods has reduced production costs of tinplate, galvanized sheets, auto body sheets and sheet steel generally to less than one half their former amounts. This has resulted in an ever widening application of strip steel to such arts as automobile and railcar construction, furniture manufacture, building construction, and many other important items. The extension of this idea of continuous production to the fin-

ishing, processing, and coating or cladding of steel is the imminent development ahead.

GEORGE T. LADD
President, United Engineering and Foundry Co.

PROGRESS
In Knowledge and Use of Steel

PITTSBURGH — In the main, the economic and social importance of the technical progress made in steel manufacture during the past quarter century lies in the fact that in this period a vast store of knowledge has been developed about the character, manufacture and use of steel. The application of this extended knowledge has resulted in the development of new steels, better steels, lower cost steels — steels that serve industry, agriculture, communication and transportation in an ever increasing range of usefulness. An important part in making possible the commanding position now held by the steel industry in the life of the world has been played by the American Society for Metals through its activity in encouraging the development and dissemination of information concerning steel.

H. E. LEWIS
President, Jones & Laughlin Steel Corp.

PROGRESS
In Electric Welding

CLEVELAND, OHIO — The entire development of welding has taken place within the last quarter century. Beginning of this period saw the introduction of the first practical arc welder by our company. Thereafter and throughout the intervening years followed a steady procession of developments, each improving welding, broadening its application, and reducing its cost — thus making its tremendous benefits available throughout industry. Today's arc welder is more efficient yet costs a fraction of what the 1915 model cost. The same is true of welding electrodes. Welding is now tremendously significant, socially and economically, as well as industrially. By improving products and lowering their cost it has made them more widely available; it has expanded markets, developed industries and increased opportunities for employment. Today's automobile, the high speed streamlined train, the airplane, the battleship, the electric refrigerator, and countless other modern advances would be impossible without it. By contributing so much to industrial advance welding has raised the standard of living, and further advances in welding will create still greater benefits in the future.

J. F. LINCOLN
President, The Lincoln Electric Co.

PROGRESS
In the Science of Metals

CHICAGO — Our contributions have been insignificant compared to those of the American Society for Metals, which has taken heat treating out of the blacksmith's shop, changed a trade to a science, made possible the development of precise heating tools to replace the forge, and changed the heat treater from a medicine man to a technician. The accomplishments of our Companies have been merely the result of industries' irrepressible demands, which have been whetted by the inspirations, dreams and successes of the metal men in industry for stronger, lighter and more uniform materials to make possible the modern methods of living. This is their anniversary and yours. We extend congratulations!

A. N. LINDBERG
President, Lindberg Steel Treating Co.
Lindberg Engineering Co.

PROGRESS
In Central Station Operation

PHILADELPHIA — During the past 25 years Philadelphia Electric Co. had a 10-fold increase in its power demand, improved its service, and constantly reduced its rates. This has largely been accomplished because of advances made in the science and applications of metals.

The development of ferrous alloys has made prac-

ticable higher steam pressures and temperatures, thereby effecting large economies in the generation of power. The progress in welding has facilitated cheaper, more reliable construction and has expedited maintenance and repairs, thereby safeguarding service. New non-ferrous metals have contributed to the advancement of reliable distribution and utilization.

The Philadelphia Electric Co. heartily congratulates the American Society for Metals on its 20th birthday and acknowledges its outstanding contributions to the art and science of metals.

H. P. Liversidge
President, Philadelphia Electric Co.

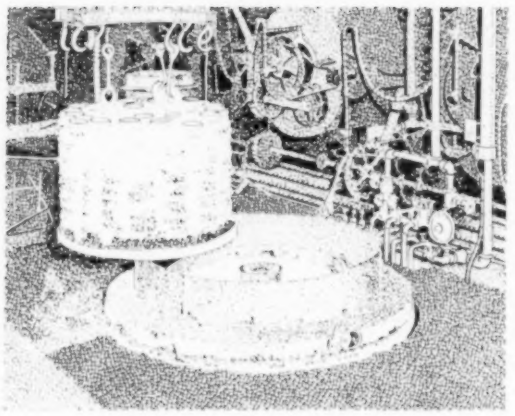
PROGRESS
In the Use of Molybdenum

New York City — Twenty-five years ago, during the early days of the societies which later became the American Society for Metals, molybdenum was virtually unknown to the metallurgist and the engineer. By 1919 the assurance of a steady supply of this element from a domestic mine at Climax, Colo., gave the steel producer and user some incentive to investigate the potentialities of molybdenum for alloying steel.

Then the nickel-molybdenum, chromium-molybdenum and subsequently chromium-nickel-molybdenum steels proved their worth during the 1920's. Molybdenum cast iron and molybdenum high speed steels came into their own during the 1930's. The phenomenal increase in world consumption, coming as it did after other alloying elements had been well established commercially, is proof of the true merits of the metal.

Climax Molybdenum Co., as a very active participant in the development which resulted in the rapid growth of the use of molybdenum, and as both an interested spectator and cooperator in the concurrent growth of the A.S.M., is particularly pleased to congratulate the American Society for Metals on its 20th anniversary, and happy for the opportunity to express its appreciation of the responsible part the Society has taken in the collection and dissemination of accurate and valuable data on a wide variety of metallurgical subjects.

C. M. Loeb, Jr.
Vice-President, Climax Molybdenum Co.



PROGRESS
In Electrically Heated Equipment

Detroit — The last 25 years have seen virtually all of the development of two arts toward which Hoskins Mfg. Co. has made some basic contributions. To the art of industrial temperature measurements we provided the inexpensive nickel-chromium nickel-aluminum thermocouple for temperatures that formerly demanded the use of platinum couples. The other art is that of electric resistance heating in home and factory. From this came a new industry for the manufacture of electrically heated equipment and also a monthly multi-million dollar heating load for the nation's electric utilities. Our contribution to electric heating has been our original development of the nickel-chromium resistor alloys.

A. L. Marsh
President, Hoskins Mfg. Co.

PROGRESS
In Titanium and Zirconium

New York City — We are delighted to cooperate with your request by informing you of some of the major developments of this Company during the past 25 years. Since the beginning of our venture at Niagara Falls we are proud to state that we have developed such useful titanium and zirconium compounds as are now used on a large industrial scale. Titanium oxide, as you know, is used extensively in paint; ferro-carbon-titanium in the manufacturing of steel; and zirconium oxide, namely "Opax", as an opacifier in the vitreous enamel industry.

William F. Meredith
President, Titanium Alloy Mfg. Co.

PROGRESS

In Efficient Steam Generation

NEW YORK CITY — Babcock & Wilcox introduced seamless stainless steel tubing in this country and developed a number of alloys for pressure tubes with resistance to corrosion and oxidation, thus making possible — or economical — numerous chemical processes including new petroleum refining operations. Another metallurgical matter in which B. & W. pioneered was the welded boiler drum that greatly reduced the cost of high pressure, high thermal efficiency boilers, and removed one of the most common sources of caustic embrittlement in boiler drums. The use of various alloys and several different kinds of welding is responsible for the modern economical boiler, which helped make possible the use of the high-pressure high-temperature steam cycle that has more than doubled the transformation of fuel energy into electrical energy in the past 25 years.

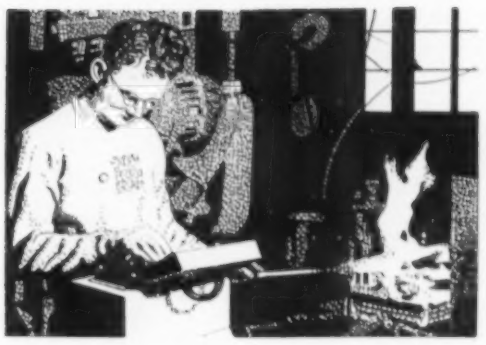
C. W. MIDDLETON
Vice-President, The Babcock & Wilcox Co.

PROGRESS

In Rolling and Drawing Machinery

WORCESTER, MASS. — During the last two decades Morgan Construction Co. has met the increasing demands for quality in rolled steel products by building into its mills features which control the accuracy of section, finish of surface and physical structure, even with increasing rates of output. This required the development of superior rolling mill machinery designed and built for reliable operation and requiring a minimum of maintenance expense. A notable development, the result of intensive research, was the application of oil film lubrication to roll neck bearings, placing in the hands of the steel companies a bearing possessing a greater load carrying capacity than that of any other type of available roll neck bearing. The introduction of multiple block wire drawing into extended use by the perfection of drawing machinery gave impetus to the manufacture of wire, and the application of wire cooling permitted ever growing rates of output.

PAUL B. MORGAN
President, Morgan Construction Co.



PROGRESS

In Rapid and Accurate Pyrometry

PHILADELPHIA, PA. — The progress of The Brown Instrument Co. during the past quarter century has been tied up very closely with the technical progress made within the metal and associated industries. We, in turn, view with pride our part in this technical advance because of the instruments and devices which it has been our privilege to develop and supply to meet the increasing technical demands made upon us. Among specific contributions we look back upon our development, through the early years of this period, of millivoltmeter pyrometers for heat treatment applications; this occurred in a succession of stages from simple temperature indicators to more elaborate recorders, and eventually to automatic control systems. This was followed, approximately ten years ago, by the introduction of the Brown Precision Potentiometer, marking a great forward step by the bringing of laboratory precision into plant temperature measurement and control. Within the past five years further notable contributions to the art have been the Brown Optimatic, permitting the measuring of temperature of rapidly moving hot bodies in the metal working field; and the Brown Analygraph, making possible the control and duplication of furnace atmospheres. All through the past quarter century, The Brown Instrument Co. and its parent company, the Minneapolis-Honeywell Regulator Co., have contributed a constant stream of less spectacular devices and instruments, which have found many and varied niches within the metal and associated industries, from the huge openhearth to the small laboratory furnace, where they are day by day contributing their small part to this great activity, "unheralded and unsung".

L. MORTON MORLEY
Vice-President and General Sales Manager
The Brown Instrument Co.

PROGRESS

In Precious Metals

NEW YORK CITY — Congratulations to the American Society for Metals and best wishes for many more successful years! Outstanding developments in our research laboratories during past 25 years include new alloys of white and colored gold, improved silver alloys for the arts, and low temperature silver brazing alloys which have revolutionized methods of joining metals and improved as well as reduced the cost of many production operations. We have developed special processes for the production of silver-clad copper, steel, and nickel for corrosion resistant equipment. Through research in powder metallurgy since 1931 we have produced and processed compositions of precious and refractory metals that cannot be produced by conventional methods. Installation by us of the first large high frequency electric melting furnace in 1920, and bright annealing furnaces in 1915, resulted in economies, controlled uniformity and better sheet and wire products in precious metals. We believe that one of our most important contributions to the precious metal and brazing industry is the constantly expanding technical service through which we have tried to assist and advise all users of the precious metals and their alloys.

G. H. NIEMEYER
President, Handy & Harman

PROGRESS

In Testing and Balancing Machines

PHILADELPHIA, PA. — During the last 25 years Tinius Olsen Testing Machine Co. has pioneered in the development, design and construction of several hundred new types and sizes of physical testing machines, testing instruments, and static and dynamic balancing machines. Among these are testing machines for accurately and easily determining the physical characteristics of all metals, whether under tensile, compression, bend, alternate, or impact stress, hardness or some special form of tests. Developments in testing instruments include extensometers and strain gages of the greatest accuracy and which are very easily and quickly operated. Balancing machines for statically and dynamically balancing rotating parts are needed to reduce or eliminate vibration and thus prolong the life of the operating unit.

THORSTEN Y. OLSEN
President, Tinius Olsen Testing Machine Co.

PROGRESS

In the Petroleum Industry

PHILADELPHIA — The demand of the oil industry for metal products necessary for cracking processes for gasoline production has led to development of many alloy steels and tremendous strides in welding technique. Oil cracking processes have conserved in excess of seven billion barrels of crude oil, thus saving an irreplaceable natural resource, and made possible an improved gasoline at lowered cost. Improved pipe and tubing have met the demand of the crude oil producer, enabling deeper drilling, and have had a large part in increasing the known crude oil reserve from five billion barrels in 1925 to 19 billion in 1939. During this period the producer has been enabled to increase drilling depths from 6000 ft. in 1925 to 15,000 ft. in 1939. The combined results of improved technique in oil refining and production enable the industry to meet a greatly increased demand for its products and at the same time steadily decrease the cost to the public and conserve the available crude oil supplies.

A. E. PEW, JR.
Vice-President, Sun Oil Co.

PROGRESS

In Control of Heat Treatment

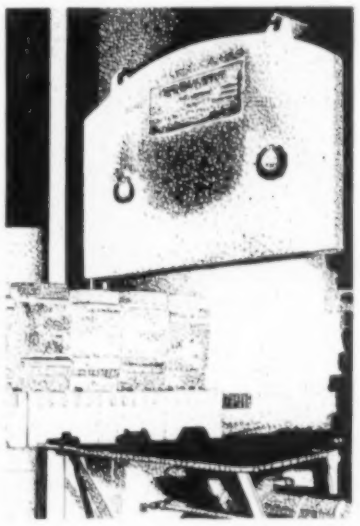
PHILADELPHIA — It has been our privilege to cooperate with progressive men in the metal and allied industries during a quarter century of transition in their heat treating processes — 25 years in which many heat treating arts have become established sciences. We have helped apply sound principles to fundamental measurements, have developed laboratory instruments and from them reliable, industrial machines for automatic measurement and control, and have had a share in the development of methods for the scientific prevention of variations in the quality of heat treated products.

C. S. REDDING
President, Leeds & Northrup Co.

PROGRESS

In Air Supply for Fuel-Fired Furnaces

HARTFORD, CONN. — The Spencer Turbine Co. has played an important part in the advancement of the metal working industries by its development of the centrifugal type turbo-compressor. Working with the manufacturers of oil-fired and gas-fired furnaces, a blower has been produced that delivers a constant flow of air throughout the range of the machine. These characteristics, so essential for the high grade work now being carried on in modern heat treating furnaces, are now considered necessities. From the very beginning Spencer has appreciated these requirements and has perfected the multi-stage compressor for low pressure air supply. Wide clearances between the moving and stationary parts assure quiet operation without interruption of service or shutdowns. The thousands of hours of operation of these blowers, and the many trouble-free installations which entirely depend on their continuous operation without loss of efficiency, is a tribute to their success.



H. H. RICHARDSON
President, The Spencer Turbine Co.

PROGRESS

In Turret Lathes

CLEVELAND, OHIO — For the last quarter century The Warner & Swasey Co. has continued to increase, to a remarkable extent, the productivity and the accuracy of its turret lathes. This has enabled manufacturers both to cut production costs and increase quality of output. The result has been a contribution to lower prices and improved quality of the countless devices which today add to the comfort and convenience of mankind, and still further raise our standard of living.

WARNER SEELY
Secretary, The Warner & Swasey Co.

PROGRESS

In Industrial Electric Furnaces

MILWAUKEE, WIS. — Significant accomplishments of Hevi Duty Electric Co. during the quarter century embody the first successful development of electric heat treating industrial furnaces. This included the first use of non-oxidizing hearth plates, first use of six-sided heat in box type furnaces, and first use of heating elements in the hearths of rotary and car bottom furnaces. This company also was successful in introducing and obtaining national acceptance of vertical retort, batch type, electric carburizing furnaces with forced convection for gas carburizing. Hevi Duty also sponsored and developed furnaces equipped with alloy elements operating at temperatures above the safe range for nickel-chromium resistors.

EDWIN L. SMALLEY
President, Hevi Duty Electric Co.

PROGRESS

In Nickel and Its Alloys

NEW YORK CITY — Significant accomplishments in the nickel industry have resulted from active technical research and development effort which, with the cooperation of industry and many individuals, has extended the use of nickel and nickel alloys. Of first importance is the number and wide diversification of these alloys, at least 2300 in number. Standardization of an extensive range of alloy steels by the automobile industry has been followed by broader industrial uses in the machine tool, petroleum, and other industries. Nickel has led in the development of alloy cast irons, resulting in engineering materials of improved performance and dependability. Some vital industrial uses are: Nickel with copper, for corrosion resistance; with chromium, for high temperature and electrical resistance; and with aluminum, in combustion engine castings. The most outstanding development has been nickel bearing stainless steels.

ROBERT C. STANLEY
Chairman and President
The International Nickel Co.

PROGRESS

In Vanadium

NEW YORK CITY — The contributions of Vanadium Corp. of America have been in fields of alloy production and steel development. We pioneered a continuous electric furnace now operating on the production of ferrovanadium; it is even now among the few continuous electric furnaces in the world. We contributed improvements in general steel quality through complex rather than simple deoxidizing alloys, such as those containing aluminum, silicon and iron with practically no carbon. We have developed constructional steels in great variety, contributing to weight reduction and hence to lowered costs of machinery and transportation equipment, largely in compositions in which high manganese content is associated with vanadium. Some of these served with excellent economy and demonstration of quality in the World War and others are now in use in the construction of defensive equipment. We pioneered the use of low alloy steels in railway construction not only along the lines indicated above but in some of the original carbon-vanadium and chrome-vanadium steels still occupying positions among the highest in respect to quantity in use and serviceability. We have recently developed new alloys for controlling the occurrence of chilled areas as well as undesirable graphite distribution in strong cast irons, thus contributing to the reliability of castings and predictability of their properties. Finally we have just produced a series of alloys contributing phenomenally to the hardening capacity of steels of fine grain size without the necessity for the use of large amounts of costly alloying ingredients. We believe these advances have aided cost reduction and quality improvement in American manufactures, thus contributing a share to the American living standard.

JEROME STRAUSS
Vice-President, Vanadium Corp. of America

PROGRESS

In Temperature Control

ROCHESTER, N. Y. — The use of instruments for recording and controlling temperature for the last 20 years and more — especially during the last decade — has shown a remarkable growth in a great diversity of applications in all industries. To mention a few, these industries include milk, oil refining, rubber, steel, canning and chemical. The importance of selecting suitable materials to give satisfactory service under such varying conditions is, of course, apparent. Metallurgy has played its part in the development of alloys which, with the specialized study necessary for their use in instruments, has resulted in recorders and controllers capable of meeting the ever increasing demand for accurate and precise performance.

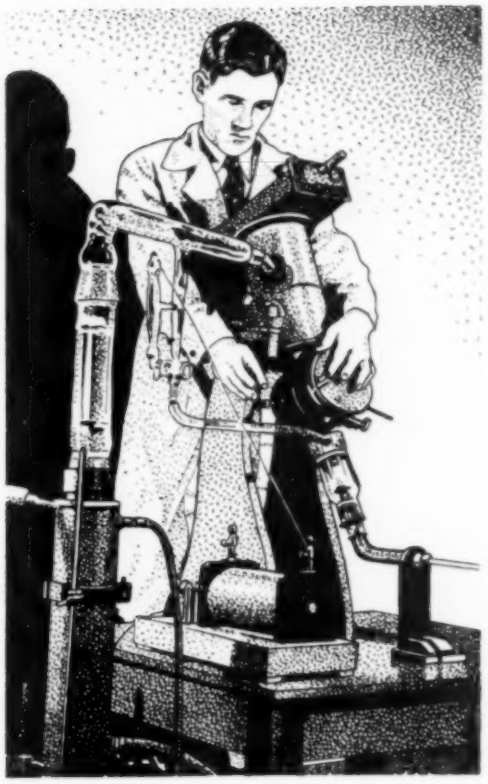
L. B. SWIFT
President, Taylor Instrument Companies

PROGRESS

In Artificial Refractories and Abrasives

NIAGARA FALLS, N. Y. — Ever accelerating progress in the metal industry during the last quarter century has been paralleled by corresponding progress in the refractories and abrasives industries. Higher temperatures have demanded and received greatly improved refractory articles, which have been made possible by the development, in the electric furnace, of artificial refractory materials. New cutting tools of extremely hard and tough alloys and of sintered powders have been met with entirely new abrasives, even to those made with diamonds. These new abrasives have contributed liberally to our present high speed, low cost quantity production and supplied the demand for commercial finishes that are measured in millionths of an inch.

FRANK J. TONE
President, The Carborundum Co.



PROGRESS

In the Utility of Metal for Electrical Equipment

SCHENECTADY, N. Y. — Electricity's contributions to America's industrial progress during the last 25 years have been particularly important. Applications of electric power and control to manufacturing — from rolling steel for automobiles to weaving cloth for dresses — have helped to improve quality and decrease cost of manufactured products. Lower production costs mean increased sales, increased production, and more jobs in industry. We believe that the best way to maintain the steady upward march of America's standard of living is through the continued creation of "More Goods for More People at Less Cost".

Successively electricity has been applied to more and more industrial processes as power, heat, or control. Operating speeds have been advanced; controls have been made more precise, faster, and more completely automatic. Witness, for instance, the modern high speed hot-strip and cold-strip steel mills, a typical example of the application of electricity to industry, and of what has been achieved through that application.

Great as is this contribution of electricity to metallurgy, the contribution of metallurgy to electricity — its production, control, and distribution — is equally important. New alloys have made it possible to operate steam turbines at constantly increasing temperatures up to 950° F., and thus at higher efficiencies and lower costs. A new cold-rolled silicon steel which reduces transformer core losses by 50% is one of the oustanding accomplishments of our Company's research scientists and engineers during this period.

General Electric scientists and engineers have made other contributions as significant as this one to metallurgical progress: Alnico, a permanent magnet alloy having greatly increased strength per unit weight and greater resistance to high temperature and mechanical shock; Trodaloy, a hard but high-conductivity copper-beryllium alloy for long-life welding electrodes. They have made possible on an increasingly large scale fabrication by electric welding; they have extended the use of powder metallurgy; and they have done fundamental research in atomic and crystal structure, throwing light on physical and magnetic properties of metals and alloys, the ultimate significance of which will be told in tomorrow's industry and tomorrow's standard of living.

CHARLES E. WILSON
President, General Electric Co.

PROGRESS

In Accurate Hardness Measurements

NEW YORK CITY — For the past 25 years we have devoted ourselves exclusively to making and continuously improving measuring apparatus to guide technical, industrial and research work of metallurgical character. Twenty-five years ago this country imported many instruments. With other instrument makers in the United States we have proved that this country is not solely adapted to mass production — as many Washington politicians believe — but can produce the world's finest measuring equipment. That proof is evidenced by large export volume during past 15 years, as European plants buy various American made instruments produced under highest labor costs for absolutely no reason except their superiority. Thousands of our "Rockwell" Hardness Testers are now in foreign plants.

CHAS. H. WILSON
President, Wilson Mechanical Instrument Co., Inc.

PROGRESS

In the Aircraft Industry

EAST HARTFORD, CONN. — The three manufacturing divisions of United Aircraft Corp., following a policy of increasing emphasis on research and engineering development, have made substantial contributions to the rapid technical advance of the aviation industry. Pratt & Whitney Aircraft Division has made continuous progress in increasing power and reliability and decreasing specific weight and fuel consumption of aircraft engines. Hamilton Standard Propellers Division has developed controllable-pitch, constant-speed and quick-feathering propellers that are in universal service. Vought-Sikorsky Aircraft Division has produced commercial aircraft that blazed the air trails across the oceans, as well as high-performance military aircraft for national defense. All these have contributed to increased speed of transportation and communication by which aviation is aiding the progress of our civilization.

E. E. WILSON
Executive Vice-President, United Aircraft Corp.

PROGRESS

In Tools for Mechanized Farming

MOLINE, ILL. — Deere & Co. congratulate the American Society for Metals on its 20th anniversary. Your Society has a remarkable record of accomplishment. For Deere & Co. also this has been a period of substantial growth. Of great importance in that growth has been the development of power farming. With power farming have come many new problems in design and materials, and these have brought an increasing use and importance of metals and metal treatment. We have fostered research and we have been able to utilize many of the newer materials which have been made available to industry. During this time the farm tractor has been developed and with it have come implements which fit the needs of the present day farmer. This has resulted in better farming and lower costs. The large number of our organization who are members of your Society is the best testimonial we can offer of the value of your work to our industry.

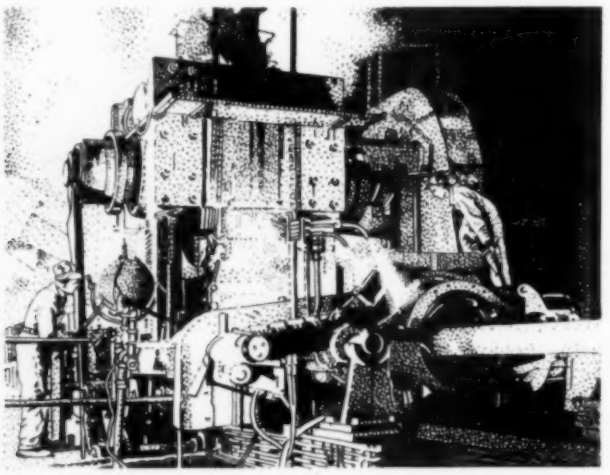
CHARLES DEERE WIMAN
President, Deere & Co.

PROGRESS

In Steel Pipe Manufacture

CLEVELAND, OHIO — Among the important developments of recent years, in my estimation, is the work done with pipe. Steel & Tubes, a Republic Division, successfully brought the process of making electric resistance-weld pipe on a small scale to the production of line pipe and casing of large diameter, resulting in vast expansion in pipe lines. The Fretz-Moon process of continuous pipe welding is important in the production of smaller diameter pipe of a uniform physical and chemical character. The work done at our southern properties in connection with the sintering of flue dust may play an important part in the future of the steel industry. Republic may also take some credit for its work with silicon strip and sheets, without which the electrical industry might find it difficult to produce fine equipment essential in power, communication and radio. Finally, Republic Steel Corp. has carried on the work with alloys so ably begun by its predecessor companies.

R. J. WYSOR
President, Republic Steel Corp.



A SHORT HISTORY
OF THE
AMERICAN SOCIETY FOR METALS

LESS THAN 30 years ago heat treating was more of an art than a science. Each treater had his own technique, and results varied according to his ability and mood. Proud of the individuality of his product, he had no desire to know what other treaters were doing. As jealous as other artists, he particularly resented those young upstarts, the "white collar" scientists, the metallurgists, who came fresh out of college classes in theory and, without any practical experience at all, presumed to criticize his methods.

In the fall of 1913, a toolsteel salesman in the Detroit area named WILLIAM PARK WOODSIDE invited 20 of his friends, most of them hardening room foremen, to meet with him at the Fellowcraft Club. He had an idea that it would be practically advantageous to form a society opposed to secretiveness in the shop. Why shouldn't the heat treaters get together and compare notes? Each man who helped another would in turn receive help, and mutual service in the way of education would avoid duplication of effort in discovering better methods, would make for efficiency and improved products generally. Probably more attracted by BILL WOODSIDE's personality than his idea, the artisans met and agreed to form a Steel Treaters Club.

WOODSIDE had also an idea that the jealousies between worker and metallurgist might be composed by absorbing some of the metallurgists into the Club. Other societies already existed for the education of the technical man to the exclusion of the practical man, but in this catholic society he wanted anyone who was interested in the advancement of the steel treating industry. Mutual education would be broadened if the man who knows could, at the same time, explain *why* the metal changes. Given a knowledge of what causes bring what undesirable qualities, the workman could thereafter avoid the causes.

At first the membership generally was not enthusiastic. WOODSIDE was probably not joking in later years when he reminisced about the third meeting of the club. A theoretically trained man was to be invited to speak, and one prospect was blackballed because he was too husky, another because he was so well-known that any injury done him would arouse comment. Finally the son of a minister was chosen because he would be obliged to turn the other cheek! One by one thereafter technical members were admitted, until by 1915 the club added the word Research to its name, becoming the Steel Treating Research Club of Detroit.

Soon executives began to join, with resulting mutual understanding of steel treating problems and executive problems. Some salesmen were also taken in, so that they might pick up the shop vernacular and talking points for their hardening room equipment and in turn give their customers' point of view to the treater and executive. Both these classes remained in the minority, however; until the mid-20's the salesmen were definitely discriminated against in many ways. Most of them at that time knew little about their product, and relied on backslapping to sell. (BILL WOODSIDE was unusual in having been a journeyman blacksmith.) It was feared, therefore, that too large a salesman alloy would contaminate the serious purpose of the Club with merrymaking. Intensely self-conscious, and sobered by the War that soon broke out, the Club in its early days devoted its meetings exclusively to papers and discussion. It

was only after the War that pleasure was mixed with business, and reports of meetings were relieved by accounts of wrestling matches which "resulted in a draw after a very high temperature had been reached. Contestants were immediately quenched in cold water", or of tournaments where "the best that can be said of these golfers is that some of them are good to their families".

It was not true, of course, that immediately after this association started no one in the steel industry ever felt jealous or secretive again. But the fact is that the ideal of friendliness and openness was given tremendous impetus because it filled a definite need. 1915's production rate of aircraft engines and trucks and automobiles was nowhere near high enough for 1917, and to supply War demands cooperative effort was essential. Self-interest dictated apparent unselfishness. When America entered the war, quarrelsome elements were inclined to mass against a common enemy. What was important now was not whether one individual could make a crankshaft that wouldn't break, but how many men could make how many such cranks. Personal pride was forgotten in a patriotic desire to serve the industry. Significantly the name of the society was changed by 1918 to Steel Treating (instead of Treaters) Research Society, and the Society incorporated.

The ideal is still, in 1940, timely. Not only is there still a degree of secrecy among manufacturing companies to be combated, but the association of men in all branches of the industry promotes a friendliness opposed to jealous struggle.

The Great Schism

To return to War days. Steel treaters from other cities began to make inquiries about joining the Detroiters, who ambitiously broadened their parochial outlook to include an exchange of information not only among themselves but between men in New York and men in St. Paul. They would become a National Society. Among the other sections or chapters formed was one in Chicago (1917), where Theodore E. Barker, chairman, and Arthur G. Henry, secretary, directed policies for the next three years. In 1918, coincidentally with the climax of the War, one of these new associates began to rebel. It didn't seem fair to the Chicagoans to be paying all their $5 dues into the Detroit pocketbook and getting no allowance in return. Eventually they took occasion to secede when a group from the organization in Detroit privately urged the membership to ignore the nominee for first national president (whom they considered not directly enough concerned with the steel business) and write in a vote for Mr. Woodside.

Messrs. Barker and Henry found themselves now directing about 200 Chicagoans, a deficit and the imposing name of American Steel Treaters' Society. The situation seemed to call for a business manager. Barker suggested the personable young school principal in his home suburb, who should be the man. He was right. William Hunt Eisenman brought to the Society, purposing to disseminate knowledge, not only training in conventional educational methods but a natural progressiveness that appreciated the possibilities in the new ideas already incorporated, and continued to provide new ideas annually from that day to this. Further, he was capable of realizing his ideas. Not apt to crack under stress of work himself, he could (and can) win other men to assist by friendliness, waggery, praise, infectious enthusiasm for the Society, and tact in his choice and presentation of facts.

Specifically, Bill Eisenman's duties included everything from establishing a library to cleaning the typewriter. Most important in the first years was the organization of Chapters. Traveling to this city and that, he would invite influential and capable steel makers and steel users to dinner, and introduce the aims of the Society so persuasively that the end of the evening would find good men in Chapter officerships. At these meetings definite arrangements would be made for the first open meeting of the newly formed Chapter a week later, at which his address "Heat Treatment, Its Past, Present and Future" would be given. Preliminary work was always so well done that the local organization was even then on its feet and many membership dues paid. In the course of a year and a half, the American Steel Treaters' Society found itself living up to its title by adding Chapters at the rate of over one a month. Today, of the 49 Chapters in the American Society for Metals, Mr. Eisenman has personally organized 41.

Besides Chapter formation, another means of embodying the ideal of cooperative education proved to be an exposition of heat treating devices and products, which had never before had a showing in America, in conjunction with the first convention of the American Steel Treaters' Society in the fall of 1919. Display

THE CHECKING OF CAMS DURING THE GRINDING OPERATION

By C. N. Dawe,

Metallurgist, Studebaker Corporation.

The cause of the checking of hardened steel during the grinding operation is a question that often comes up in the manufacture of the automobile, as well as in the other industries. Occasions such as this have been noted in plants where the different departments were grinding cam shafts from the same hardening room. In one of these departments the foreman complained that many of the cams were checking, while no such complaint was received from the foreman of the other department. This was simply a case of the former pushing the work too hard at a time when the steel would not stand it. From this it is evident that the foreman must use some discretion as to how hard he can push his work and still turn it out satisfactorily. There appear to be times when the steel will not stand the rough handling that it ordinarily receives.

The water or brine hardened case on a piece of carbonized steel which is to be ground, is, at the best, in a strained condition. The water or brine quench with no draw leaves the case in this condition. If a grinding wheel is pushed against this strained surface with considerable force, it is not surprising that it becomes checked.

Although checking is comparatively rare considering the amount of material that goes through the grinding operation every day, two or three conditions are here presented, which may account for the fact that grinding checks appear in steel at some times more than at others.

If during the carbonizing operation, conditions are such that a carbon percentage of one per cent or more is on the outside of the case, upon cooling down there is present in this high carbon portion of the case, a net-work of cementite surrounding the individual grains of steel. This cementite is a glass hard brittle constituent. If, when the piece is hardened and this net-work is not broken up, the hard grains of steel next to the surface of the piece are then still surrounded by this brittle net-work. This cementite, of which the net-work is composed, expands more on heating than the grain which it surrounds, thus when heated and hardened the net-work puts added strains in this portion of the case by closing in on each grain. It has been found that heating the carbonized piece for half an hour at the hardening temperature has no tendency to break up this net-work. It is a condition that should be avoided in the hardening room.

The matter of gases dissolved in steel undoubtedly at times enters into this question of the apparent brittleness in steel.

It is a well known fact that hydrogen absorbed by steel during a pickling operation makes the steel extremely brittle, whereas baking the steel for a short length of time (two to three hours), at a moderately low temperature will drive out the hydrogen.

Metallurgists have also proven the fact that dissolved nitrogen causes steel to be very brittle if present in sufficient quantities. It has been found by experimenting that .03% to .04% nitrogen in a high carbon steel causes it to lose all toughness. If then the original low carbon steel which is to be carbonized contains .03% to .04% nitrogen, a condition which may be expected, after carbonizing we have in the case a high carbon steel with the percentage of nitrogen stated, and thus a brittle condition over the surface of the piece to be ground.

Another point has been observed which indicates that forging strains have something to do with checking. During a period when considerable trouble was encountered with the checking of cam shafts, it was noted that the original cam shaft forging was not being heated sufficiently high enough after the forging operations to remove all forging strain. This heat was raised and at the same time the trouble with checking ceased. This may have been simply a coincidence but it is well worth noting.

We can see then, if the above conditions affect the steel as stated, that the blame for checking is not always with the hardener or with the grinding room foreman, and not always on the steel. The question must be looked at from every angle, and it is such problems as these that science, together with the aid of the practical man, is endeavoring to solve.

Technical addresses before the Steel Treaters Club (later the Steel Treating Research Club of Detroit) were published as leaflets for ring binder. Above is a facsimile of the first publication of the first "formal" paper; it was presented during the winter of 1913-1914

space could be rented to manufacturers, who could show examples of the technical advance described that same week in the metallurgical sessions, as well as sell to the practical man and executive. All the important men would one day foregather from all over the country, and corridor conclaves would be as worthwhile as a college course.

Nevertheless, somewhat doubtful of initial success, the Society set the date for the same week as a convention of the American Institute of Mining Engineers in Chicago, in hopes of attracting some of the larger organization's members to look in. This first exposition at the 7th Regiment Armory was the only one in the history of the Society to be opened with official prayer. Actually there need have been no fears — at least 10,000 people, a high percentage of them prospective customers, came to look, and no less than 500 among them applied for membership in the Society! It was a lucky time to begin exhibiting, for the next 20 years were to prove the heyday of world fairs and other expositions.

Steel Treaters Re-United

The War was over by now, and men of the sword were beating out ploughshares. Col. Albert E. White, formerly of the U. S. Army's Ordnance Dept. and currently Associate Professor of Metallurgy at University of Michigan, began during 1919 to suggest an end of hostilities between the American Steel Treaters' Society (Chicago group) and the Steel Treating Research Society (Detroit group). He pointed out that contrary to their expressed purpose of cooperation to avoid duplication of effort, they were competing one with the other, wasting energy in personal quarrels that might have gone to advance industry. In Pittsburgh Col. White received unexpected support from two Chapters which had been formed by the two rival organizations on succeeding days, but which, being composed of individuals previously friends and with a generous overlap of personal memberships, could not see any reason why they should separate now. It wasn't long, therefore, before representatives of each Society, with Col. White as a mediating neutral, battled out differences at Battle Creek, and a new, amalgamated Society celebrated its armistice in Philadelphia (where the second exposition was concurrently held) in the week of Sept. 14, 1920.

Necessary compromises were, after all, minor. One created a name that was a mixture of the old names — the American Society for Steel Treating. Each of the old Societies wished the national office to be located on its own ground. Both Detroit and Chicago were therefore passed over in favor of Cleveland. Rented offices, first at 16th and Prospect and later at East 71st and Euclid, have housed the directing activities until the present, when a permanent home, a fine old stone mansion at 7301 Euclid Ave., has been purchased from the Norton family — another pioneer, a family early in the iron ore business.

Steel treating did not long remain the Society's exclusive concern. Alloying during the manufacture of steel soon approached heat treatment in importance, and the quality and treatment of non-ferrous as well as ferrous metals began to attract the attention of consumers. Wisely keeping abreast of the times, the Society expanded its field by 1924 to include the whole manufacturing process of any metal. Reluctant, however, to change its by now well-known name for the sake of consistency, the Society continued with the old one until convinced that membership and convention support would be increased by the use of a more inclusive name. In 1933 the word "Metals" was substituted for "Steel Treating" to form the present title for this much-christened American Society for Metals.

The underlying purpose of promotion, of getting together to push industry (and incidentally each other) was agreeable to both of the formerly hostile groups, and has never changed.

It has not always been possible to carry through all the projects promoted in the early days. A standing Research Committee, after preparing lists of subjects ripe for study to give any interested individual or institution, proposed to establish a laboratory, but this had to be abandoned for lack of funds.

On the other hand a standing Recommended Practice Committee has been most successful, once it overcame a false start. Born a Standards Committee, it examined the work done by other Societies and concluded that the writing of specifications would be a duplication of effort. By 1923 it transferred its interest to the formulation of recommendations for good practices in heat treatment, which would advance industry more than recording standards already set up; it would also be a novel venture. As a matter of fact, the publication of a Handbook of Recommended Practices had been in the

agitational stage for some years already, during which Secretary EISENMAN had used the prospect as one of the lures for support in prospective Chapters. Action was postponed because of disinclination to put the Society's name behind recommendations which might be of questionable desirability.

Such doubts were dispelled by soliciting the cooperation of all possible interests on a single committee, and requiring substantial agreement before publication. Finally, in 1921, work began under the direction and assistance of J. EDWARD DONNELLAN, Recommended Practice Committee secretary, who proved himself so well suited to a job requiring strict exactness in both large and small matters that he is still carrying on the work. Committee work, once begun, grew rapidly. From time to time, as subjects were proposed, the parent committee would assign the task of preparing a tentative procedure to a subcommittee or individual. When written these procedures were sent out to the interested membership and when they had been returned with criticism, the authors would work over all suggestions before submission of final recommendations to the parent committee (which, on acceptance, would dissolve the committee until time necessitated revision). These were then printed in "Lefax" size data sheets for ring binders, and sent to the members periodically as a supply accumulated.

The first of these data sheets were posted in the latter part of 1923. By 1928 loose-leaf data books had been supplanted by the first of the bound Handbooks, which was sent free to the members. It numbered 600 pages, where the most recent edition of Metals Handbook, published in 1939, boasted 2000. (Complete data on these editions are included in the accompanying table.) In order to withdraw obsolete Handbooks from circulation, members return the old before being sent the new edition, and receipts in the national office (including everything from S.A.E. Handbooks to tubes of tooth paste) have indicated a general demand for the product of the Recommended Practice Committee (now called the Metals Handbook Committee).

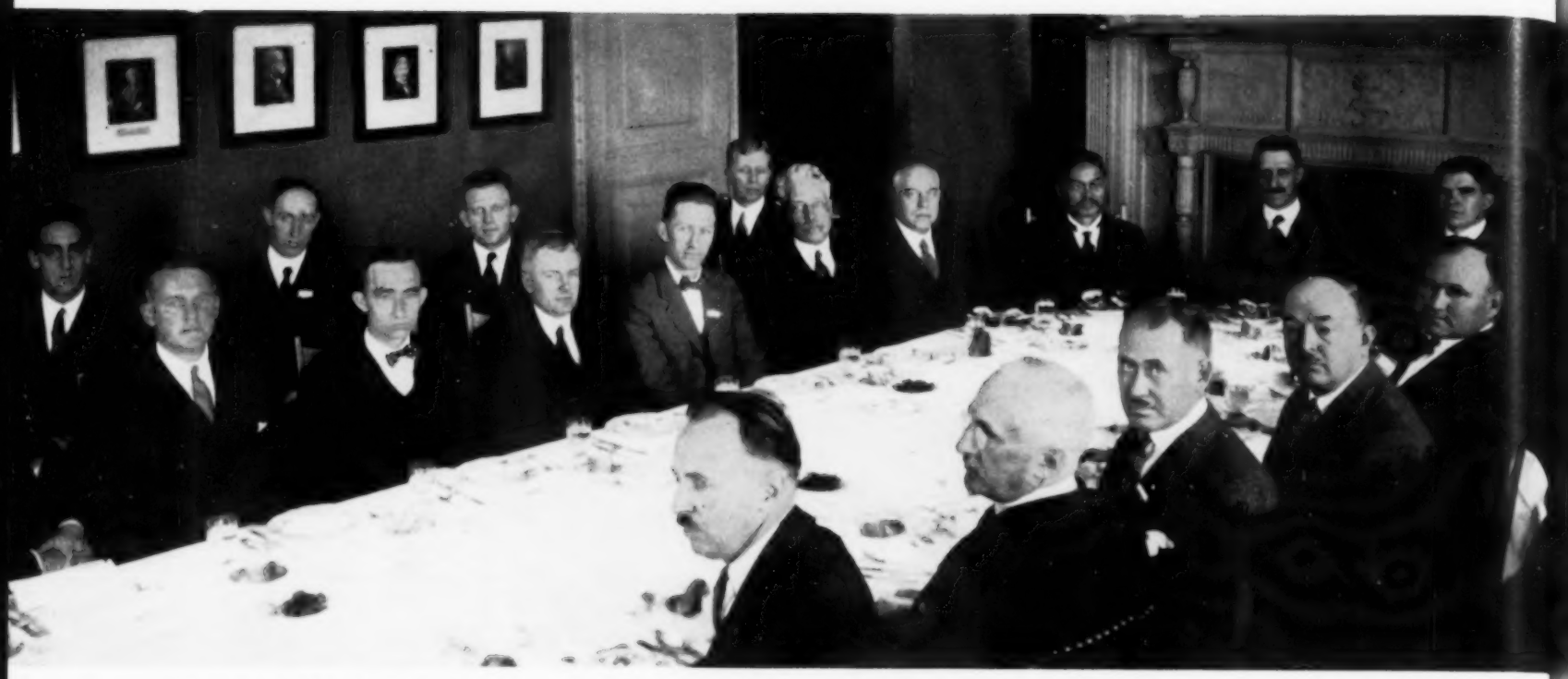
This committee has set an example for cooperation to the Society. Starting from a group of three men it has grown until 51 subcommittees totaling 800 men worked unselfishly on the last edition. Occasionally a single subcommittee has worked as long as 10 years. To the satisfaction (and surprise) of the committee secretary, Mr. DONNELLAN, there has never been any difficulty in persuading members to put in many hours of work, unpaid by anything more concrete than gratitude and respect.

It is not to be understood, however, that cooperation has existed only among the membership. Beginning in 1921, representatives have often been appointed to assist some other organization in a project, or other societies have been invited to participate in a Society committee or convention. When, by 1927, the great mass of non-ferrous material in the Handbook was studied, the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers was asked to assist in its expansion — an invitation cordially accepted. This arrangement has resulted in a notable non-ferrous section in the Handbook, in itself a splendid contribution to metallurgical literature. As another phase of cooperation, numbers of technical societies have made it a custom to hold annual meetings at the same time and place as the , to give papers simultaneously, and to a lesser degree to exhibit also. By 1931 this fact suggested the name of National Metal Congress for the convention.

The Congress has occupied an increasingly important place in Society attention. The location alternates between East and West, as an accommodation to various sections of the membership, and is almost

Growth of Metals Handbook

EDITION	PAGE SIZE	PAGES	ARTICLES
1924 A.S.S.T. Handbook, Loose-leaf			
Ferrous	6¾ x 3¾	521	73
Non-Ferrous	6⅝ x 4	287	62
1929 A.S.S.T. Handbook			
Ferrous	7 x 4	501	74
Non-Ferrous	7 x 4	91	26
1930 National Metals Handbook			
Ferrous	7 x 4	617	95
Non-Ferrous	7 x 4	219	52
1933 National Metals Handbook			
Ferrous	7 x 4	976	141
Non-Ferrous	7 x 4	455	93
1936 A.S.M. Metals Handbook			
Ferrous	8⅞ x 5⅝	876	180
Non-Ferrous	8⅞ x 5⅝	465	155
1939 A.S.M. Metals Handbook			
Ferrous	8⅞ x 5⅝	1195	229
Non-Ferrous	8⅞ x 5⅝	568	200



Many notables in Society History Gathered at This Small Dinner at University Club, Boston, Given Sept. 24, 1924 in Honor of Kotaro Honda, Honorary Member ❁, by George B. Waterhouse. Clockwise around the table the men are:

HERBERT J. FRENCH, *physicist at Bureau of Standards (now in charge of alloy steel and iron development, International Nickel Co.)*

ROBERT M. BIRD, *of G. F. Pettinos' organization (now district manager of sales, The Midvale Co.)*

D. J. MCADAM, JR., *Experimental Station, U. S. Navy (now with Division of Metallurgy, National Bureau of Standards)*

†F. C. LANGENBERG, *metallurgist at Watertown Arsenal*

EDGAR C. BAIN, *Union Carbide and Carbon Research Laboratories (now assistant to vice-president, U. S. Steel Corp.)*

PAUL D. MERICA, *director of research (now vice-president, International Nickel Co.)*

SAMUEL L. HOYT, *research laboratory, General Electric Co. (now technical adviser, Battelle Memorial Institute)*

CHARLES E. MACQUIGG, *metallurgist, Union Carbide and Carbon Research Laboratories (now dean of engineering, Ohio State University)*

†ALBERT SAUVEUR, *professor of metallurgy, Harvard University.*

†GEORGE K. BURGESS, *director, Bureau of Standards*

KOTARO HONDA *(now president, Tohoku Imperial University)*

GEORGE B. WATERHOUSE, *professor of metallurgy, Massachusetts Institute of Technology*

†F. C. A. H. LANTSBERRY, *managing director, Jessop Steel Co., Sheffield, England*

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ZAY JEFFRIES, *Research Department, Aluminum Co. of America (now technical director, Incandescent Lamp Dept., General Electric Co.)*

†HERBERT M. BOYLSTON, *professor of metallurgy, Case School of Applied Science*

OSCAR E. HARDER, *professor of metallography, University of Minnesota (now assistant director, Battelle Memorial Institute)*

†EDWARD D. CAMPBELL, *professor, Univ. of Michigan*

E. D. CAMPBELL, JR.

invariably located in an industrial center to permit of plant visitations during the five-day session.

The Exposition has also undergone many changes during the 20 years since the first one in Chicago (prior to the amalgamation). As manufacturers became convinced of the sales value of exhibiting, space rentals increased until few exhibition halls across the country are large enough to house the show; as exhibitors became acquainted with the education and training of the visitors they replaced ballyhoo artists in the booths by salesmen who were also metallurgists and executives. The subject matter broadened, along with the field of the Society, from heat treating appliances to the whole metal industry, from raw material to finished product. Most striking change of all was in the appearance, which maintained a certain continuity only in polish and precision, qualities inherent in the products shown. The attractive value of motion was soon appreciated; live exhibits replaced dead ones; movies were set up, puppet shows produced. Wicker furniture gave way to luxurious appointments.

In the 1920's the fullest possible use of space was made, each manufacturer somehow cramming samples of every product into his booth, decoration being thrown in in the form of flags and greenhouse products. Around 1929, and even more after the Chicago Fair, an attempt at

the most effective use of space introduced a new simplicity. One important product might be emphasized by size or repetition, by a colored background or play of light, while surrounding empty space relieved the eye of a sense of clutter and strain. As art schools began to talk about the sculptural values of metal work — its luster, texture, and so on — the necessity for extraneous decoration disappeared. Companies specializing in artistic exhibition were employed to put whole exhibits together and crate them complete to the hall.

One disadvantage in the eye appeal was the fact that, although no attempt was ever made to draw any but members or customers, John Public began to attend in such quantity that after 1936 the management found it necessary to exclude all but members and invited guests. Whenever registration of attendance has been taken, over half the membership has been found present.

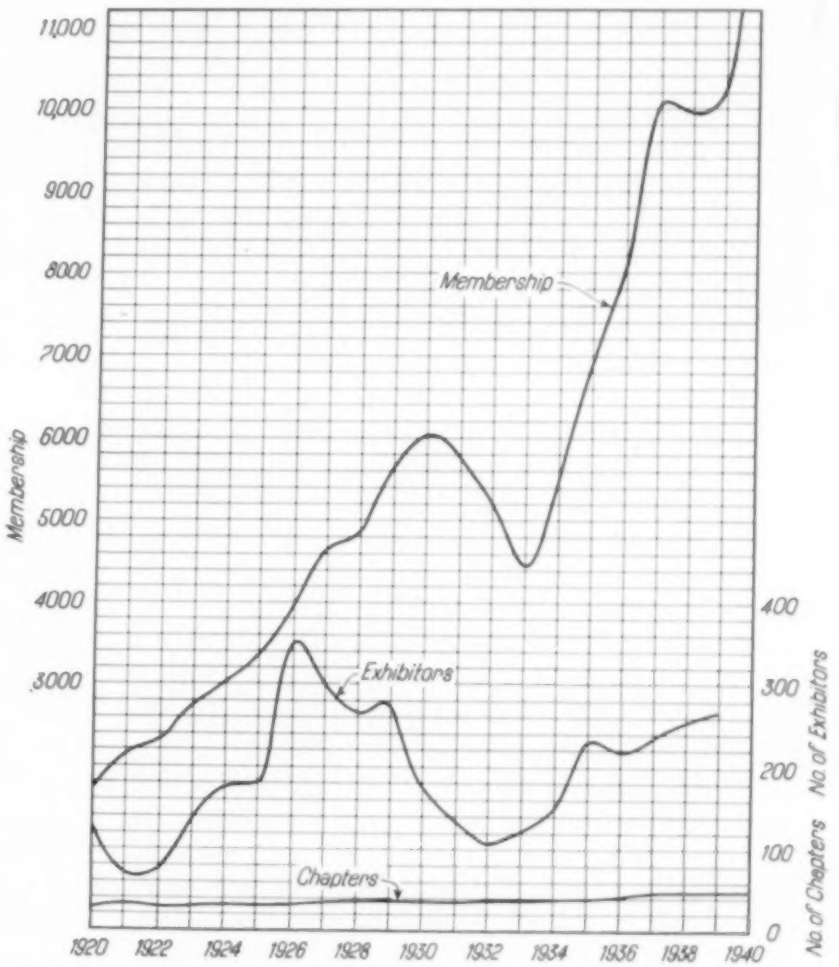
Very early the business management of the conventions was taken over by the national office, and by 1927 even the arrangements for entertainment were found too burdensome for the local Chapter, which thereafter maintained only an advisory capacity.

For the technical sessions, members who have developed some new process have always been invited to read papers. At the 1921 convention difficulties were encountered from too enthusiastic a reply to invitations: 75 papers were presented in five days of simultaneous sessions. As a further complication, the speaker often talked so long that discussion had to be cut or eliminated. Even where there was discussion it did not seem worthwhile. In after years speakers have been strictly held to the time limit; authors were slowly persuaded to write their papers long enough in advance to preprint, thus bettering the quality of discussion, and the total number of papers given by ASMembers was cut to between 30 and 40. Either before or after the conventions all the papers and discussion have found their way into *Transactions*, the publication that replaced the *Journal* of the American Steel Treaters' Society and the *Proceedings* of the Steel Treating Research Society in the task of record-keeping and correlation of experience.

To the author of the best paper published in *Transactions* is given a Henry Marion Howe medal, the presentation being made at the banquet held during the convention. Also awarded on this occasion are: A medal to the past President (along with the Henry Marion Howe medal, this was first presented in 1923), a certificate to the E. D. Campbell Lecturer (an institution since 1926), and the Albert Sauveur Achievement Award for metallurgical research proven in time to have affected industry. This last was given for the first time in 1934 in honor of a man who had always urged the Society's ideal of advance.

Two metal congresses were held in 1929, 1931 and 1938, when replicas of the National Metal Congress took place in California to accommodate the growing far western Chapters and to dramatize western industrial advance. Called the Western Metal Congress, they have enjoyed the assistance of all 12 national technical societies with coastal groups.

Growth in Membership Has Been Steady, Except During the Worst of the Depression. Number of exhibitors, each taking generous space, taxes the capacity of America's largest exposition buildings



Another type of convention has been the sectional meetings, where several neighboring Chapters gather to discuss papers and visit plants for one to three days. During the 1920's these were held (usually semi-annually) where hotel or show facilities were not large enough to house a Metal Congress, and far enough from the location of that year's Congress to draw members unable to attend the main convention because of time and expense.

These sectional meetings proved to have definite social advantages, and for a number of years they were supported financially by the national office, until expenses were found to be disproportionate to attendance. Since then sectional meetings are held by groups of contiguous Chapters, which make their own arrangements.

The Chapters, also socially advantageous, have not weakened in the course of time. On the contrary, since the beginning the strength of the Society has been in the Chapters and Chapter meetings, rather than in conventions or in the national office. (In this, it may be pointed out, the American Society for Metals is unique among technical societies.) The theory is that Tom Jones is more likely to discuss his problems with a small group of men he knows than with a large one he doesn't know or an impersonal committee or name in the national office.

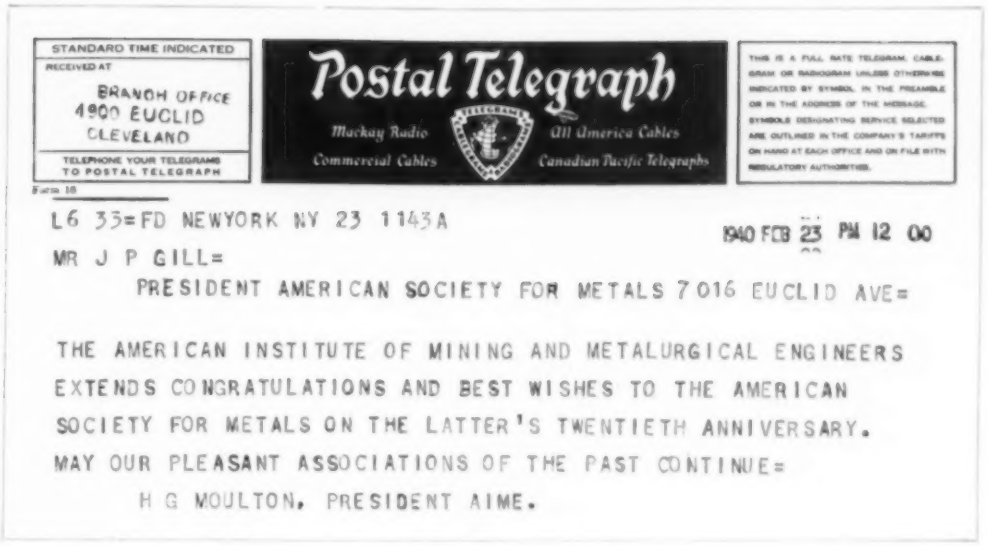
On the whole the national office maintains an advisory capacity. The president, elected for a term of one year, and the secretary (WILLIAM H. EISENMAN, since 1920) visit a majority if not all of the Chapters each year, to observe and recommend, as well as receive Chapter suggestions for national direction.

That the membership has actually been attracted through the Chapters is indicated by the fact that a National Membership Committee, standing since 1920, was disbanded in 1927 for lack of work. The membership was continuously growing without its efforts. At the time of amalgamation there were 1724 members, and net increases were recorded for every year except 1931, 1932, 1933 and 1938, until at present there are over 11,200 members. Not only was there a net increase in numbers, but the Chapters achieved a greater degree of stability in the course of time. Mr. EISENMAN tells a story about the first resignation received after he came with the Society, from a man on the outskirts of Chicago. Upset over the discovery that someone could lose interest in the Society, he spent hours transferring from street car to street car, in order to reach the recalcitrant. He learned that afternoon that the personal touch has greater impact than pleas hammered down by an unknown signature. In after years Chapter officers have been urged to follow up their own members — which they effectively do.

Permanent Home of American Society for Metals, Occupied Feb. 26, 1940

Among other factors in a stable membership have been Chapter programs, which since the early twenties have been mainly arranged in advance for a fixed date and permanent meeting place, and have been as closely as possible tied up to the interests of the members. From the national office comes help in the form of a speakers' directory, and all over $6.50 of every member's dues is returned to the local Chapter to finance its activities.

After 1933 membership rolls increased by a phenomenal percentage, partly because of the changed name, but probably more because of



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MR J P GILL=
PRESIDENT AMERICAN SOCIETY FOR METALS 7016 EUCLID AVE=

THE AMERICAN INSTITUTE OF MINING AND METALURGICAL ENGINEERS EXTENDS CONGRATULATIONS AND BEST WISHES TO THE AMERICAN SOCIETY FOR METALS ON THE LATTER'S TWENTIETH ANNIVERSARY. MAY OUR PLEASANT ASSOCIATIONS OF THE PAST CONTINUE=
H G MOULTON, PRESIDENT AIME.

the prerequisite of membership for the educational courses offered by many Chapters. The prerequisite was an innovation, but the courses had been carried on ever since 1920, when the new Society realized that it would have to increase its efforts along educational lines. Chapters here and there volunteered to lend their technical men for night-school courses, in local educational institutions, or gave courses independently. They proved so popular that more and more Chapters have followed the precedent since then.

By 1922, *Transactions* began to mirror the trend. Besides continuing its "comprehensive survey of technical data" in convention reprints and abstracts, RAY T. BAYLESS, its new editor, began to solicit contributions on subjects which would give the shop man a broadening educational course in fundamental principles.

By 1927 the national office was also cooperating by sending the late Prof. JOHN F. KELLER of Purdue University to give extension courses in various cities. Called the "learned blacksmith" to indicate his nice balance between theory and application, Professor KELLER served the purposes of the project excellently for some years by fundamental lectures having engaging titles like: "Why Steel Warps".

Attendance records kept at these meetings brought out an interesting item: The percentage of shop men was declining. The fact was that the man at the fire was no longer as important in the industry as he had been before the War. His judgment was not essential, now that directions no longer called for heating to a "cherry red" but to 1475° F. Metal treatment was no longer solely an art but beginning to be a science. With accumulation of information, and mutual education, exact reproduction of result had become possible. Also, increasing mechanization had supplanted the muscular arm of the man at the fire.

The important fellow now was the man at the controls. The engineer who read the pyrometer was probably lacking in the manual skill of the mill man or melter, and in the technical training of the research metallurgist. But he would probably have a general education that induced a greater aptitude for fundamental principles than his strong-armed predecessor had shown. He could understand Professor KELLER's language, and he frequented his classes. Also present were a growing number of executives and salesmen, with about the same educational preparation as the engineers. "They do not spend all their time on metallurgical problems; metal, however, like labor and money, is one of their principal raw materials . . . They have a healthy interest in new developments in this raw material, or in methods of processing, heat treating or finishing it . . ."

By 1931 it was found that three out of four members of the Society could be classified as executives, engineers or production men. Since then *they* have been the target for education instead of the shop man. The work has been carried on not only by continued interest of the Chapters, but by increasing activity in the national office. Lecture series given by members have been published and sent out along with slides for use in Chapters. Since 1934 a national committee has studied the possibilities in visual education, and begun a movie about metallic crystals. Book publication has grown from an occasional binding of convention papers 15 years ago to a major educational venture including books ranging from testing methods to alloy steels. Since 1934, also, two series of lectures have been given at each Metal Congress, relieving the very scientific tone of the technical sessions with somewhat more practical appeal.

In 1930 a new monthly magazine began to be published to cater specifically to the new majority. Its name, *Metal Progress*, was indicative of its function of reporting news of advances in the industry to the men now most concerned with keeping up with the times. Its

editor, ERNEST E. THUM, was (and is) notable for conciseness and clarity in editorial presentation, and for curiosity about the outlying effects of such news on human happiness.

Metal Progress has not been just another magazine. Mr. THUM, the editor, had for some years before undertaking his duties been interested in the fact that although other types of magazines and advertising were developing eye appeal, metallurgical magazines were attractive only in content. From the beginning, therefore, *Metal Progress* featured illustrations that were more than statements of fact — a plant stack might be taken from an emphatic angle; the interesting pattern of a photomicrograph might be brought out. Pictorial stories were introduced; covers were designed to do more than jacket the magazine; page layouts were balanced and the typography was made pleasing instead of eye-straining.

This activity was just another instance where the ASM developed an idea before anyone else, at a time when it would be generally welcomed. The reward was success. The American Industrial Advertisers Association cited it in 1938 (in the *Industrial Marketing* competition) as having had a "uniquely high standard of typographical excellence", and in 1939 a first award for editorial achievement in the publication of pictorial stories. A survey in 1938 by the Market Research

Beside Six Editions of the Handbook, 20 Years of Transactions, *10 Years of* Metal Progress *and* The Review, *the* ASM *has published 26 books. A list of them, with date of first edition, is printed at the right*

Application of Science to the Steel Industry, by W. H. Hatfield (1928)
Principles of Steel and Its Treatment, by Metallurgical Department, Bureau of Standards (1928) (out of print)
Inclusions in Iron, by C. R. Wohrman (1928)
Nitriding Symposium, Edited by R. T. Bayless (1929)
Heat Treatment, Uses and Properties of Steel, by H. B. Knowlton (1929)
Lectures on Steel and Its Treatment, by John F. Keller (1930)
Quenching of Steels, by Herbert J. French (1930)
Constitution of Steel and Cast Iron, by Frank T. Sisco (1930)
Tool Steels, by James P. Gill (1934)
Grain Size and Grain Size Control, A Symposium, Edited by R. T. Bayless (1934)
The Book of Stainless Steels, Edited by Ernest E. Thum (1935)
Metallurgical Dialogue, by Albert Sauveur (1935)
Principles of Heat Treatment, by M. A. Grossmann (1935)
Engineering Alloys, by N. E. Woldman and A. J. Dornblatt (1936)
Physical Testing of Metals, by H. D. Churchill (1936)
Steel Physical Properties Atlas, by C. Newman Dawe (1936)
The Working of Metals (17 papers by leading authorities) (1937)
Open-Hearth Steel Making, by Earnshaw Cook (1937)
Metallographic Technique for Steel, by J. R. Vilella (1938)
Carburizing Symposium (1938)
Machining of Metals (A series of papers) (1938)
Hardenability of Alloy Steels (A series of papers) (1939)
Forging Handbook, by Waldemar Naujoks and D. C. Fabel (1939)
Metals Handbook, Edited by J. E. Donnellan (1939 Edition)
The Alloying Elements in Steel, by Edgar C. Bain (1939)
Modern Steels, Manufacture, Inspection, Treatment and Uses, by M. W. Lightner, G. R. Fitterer, Ernest E. Thum, Franklin H. Allison, Jr., A. W. Demmler, J. P. Gill (1939)

Corp. found that 99% of the membership read the magazine, 67% finding there something they get nowhere else. *Transactions*, which had grown enormously by 1930 in an attempt to cover all the interests of all the membership, thereafter devoted itself exclusively to technical papers. It was thought that this matter could be covered by semi-annual publication, but popular demand has increased output to a quarterly basis for the last six years. Although reduced in size since the introduction of *Metal Progress*, *Transactions* has in the course of its 20 years' history produced a greater volume of material than any other of the Society publications. No less than 1131 author-experts have contributed 1153 technical and scientific papers, totaling 22,576 pages of text and illustration, exclusive of Chapter news and advertising.

A Publication Committee has always assisted the editor of *Transactions*, and still functions in appraising the value of papers. Factors such as the subject and whether it is treated in an interesting way are considered in relation to the Society membership and magazine standards. The men on the committee, staggered in their terms, are appointed for a period of three years each.

Mr. BAYLESS, famous now for his insatiable appetite for work, is still the editor of *Transactions*, and since 1930 has added the duties of Assistant Secretary of the National Society and editor of a third periodical, christened then as *The Review*, and designed to separate Chapter and Society news from *Transactions*, where it had formerly been carried.

A final activity of the Society should perhaps be mentioned more for its promise than performance, even though it has existed since before the formation of the A.S.S.T. The *Journal* of the A.S.T.S. used to carry an employment service, whose justification was service to industry by finding the right man for the right job. Continued for years by *Transactions*, the service has been greatly extended during the last year by connections between the national office and 35 technical employment agencies throughout the country.

In the year 1940, the American Society for Metals finds itself 20 years old (or, if its progenitors be counted in, 27 years since its first lusty appeals for attention). It has survived two depressions and some internal disturbances. It will doubtless continue to survive as long as it continues to adapt itself in some unique way to the needs of a changing civilization. D.F.T.

American Society for Metals

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HEATING MEDIUMS

By Matthew H. Mawhinney, Consulting Engineer

As it was in **1915**

Coal continues as an important fuel in metallurgical furnaces, although there is an increasing interest in better control than is possible with hand firing. One step in this direction is the considerable use of stokers in the sheet mills for proper heating of the product.

Another fuel capable of somewhat better control is producer gas made from bituminous coal. For several recent years natural gas at a cost of 12¢ per M. cu.ft. in the Pittsburgh district has provided a fuel so cheap that some producers have been shut down, but it is probable that the present European War if continued will change this in favor of producer gas.

Fuel oil is used in a number of places, particularly where good control is required in smaller furnaces for heat treating. Oil, natural gas or coke oven gas is particularly desirable in these furnaces because the operator may regulate small quantities of fuel with considerable accuracy. Also, the proper amount of air may be supplied under pressure from a blower, which undoubtedly improves the efficiency of combustion.

Research is in progress on the burner equipment for gaseous fuels; so far these devices are too complicated for any general application and do not show sufficient savings to justify their use except in the small furnaces requiring very accurate control.

Electric resistance furnaces are being advanced for fine heat treating work requiring the most accurate temperature control, but the cost of operation is very high compared with fuel fired furnaces. On account of the fact that no combustion gases contaminate the work or the premises, there is increasing interest in electric furnaces in the heat treatment of automobile parts.

There is a noticeable tendency toward better heating in the metallurgical field, and many improvements can be expected in industrial furnaces. The problem is to provide the heaters with better control of their fuel without increasing the heating cost beyond reason.

As it is in **1940**

The principal concern of the fuel engineer is the supply of fuels which seemed so plentiful and cheap 25 years ago. We must conserve those fuels which are capable of the control so essential to our highly developed automatic furnaces.

Coal as an industrial furnace fuel has almost disappeared but will probably revive for rough heating operations as other fuels are depleted. Very few gas producers have been purchased in recent years but many old producers are still in operation on the openhearth furnaces, soaking pits, and billet heating furnaces. Clean gas from anthracite coal and coke is attracting increasing interest where there is a shortage of natural gas, because this gas can be made at a reasonable cost and accurately controlled in modern burners.

Fuel oil remains a major fuel for all except the so-called "controlled atmosphere" type of furnaces, and can be handled with reasonable accuracy by modern automatic controls. The present European War will absorb much of this naval fuel.

Gas remains the only perfect fuel for all heating operations. Automatic temperature and atmosphere control seems to have nearly reached theoretical perfection. Since, however, this perfection in open furnaces still falls short of the demands of the metallurgist, the development of indirect fired furnaces with protective gas atmospheres is progressing rapidly.

Furnaces heated by internally fired tubes and by electricity have so far best met the needs of this type of furnace. The requirements of bright annealing have rescued the electric resistance furnace in its losing race with the modern automatic gas furnace.

It is probable that future advances in furnace design will be in the field of atmosphere heating, while the development in fuel technology will be in the direction of the production of artificial, form-value gases capable of meeting the furnace requirements, and made from coal to replace the natural gas as depleted.

PROTECTIVE ATMOSPHERES

By William S. Bidle, President, W. S. Bidle Co., (Past-President ASM)

As it was in 1915

MANY OF US find it difficult to fix our attention on affairs close at home because of the danger of getting drawn into the European War. The President's friends seem to be preparing a campaign for re-election based on "He kept us out of war".

Compared with this problem of national importance, the problem of heat treating steel without undue scale, or with no scale at all, seems a very minor matter. In the furnace of most general use, with open chamber ("box-type", so-called) the first endeavor is to run with a smoky flame or a surplus of gas. While this actually minimizes the scale, the parts are likely to quench out soft to the file — a phenomenon not well understood. A sharp or oxidizing flame produces a scale that is easier to remove, and a hard surface underneath.

Pack annealing and pack hardening (where the steel is placed in pipes or boxes with fine charcoal and the container sealed with clay) is the universal method in use where scaling and decarburizing are both to be avoided. Its principal disadvantage is the cost of fresh packing materials and the time and heat required to bring the excess mass up to proper temperature. For certain large toolsteel dies the steel maker prescribes packing in very clean cast iron chips, and a treatment program taking as much as 72 hr. This is an extended and costly treatment and possibly might be improved upon by new steels or new furnace methods.

Heating small parts in a cyanide pot is quite common, in some cases for the benefit of the extremely thin hard case imparted to the soft steel, in other cases mainly for the pretty mottled surface effect of color, and the absence of scale. Recent news about "activated" cyanides, and even other salt compositions melting at various temperatures, for use in heating steels has been reported, but it is anticipated that much difficulty will be experienced with them at high temperatures.

The lead pot is a familiar melting medium; one difficulty with it is the comparatively short life of the containers.

As it is in 1940

Many of us find it difficult to fix our attention on affairs close at home because of the danger of getting drawn into the European War. We are in the eighth year of the New Deal, when controlled atmospheres are much discussed by the metallurgical fraternity, but are more than ever prominent by their absence from Washington.

Oxygen, carbon dioxide and water vapor are the generally admitted miscreants, and if we can dispose of these from the furnace atmosphere all scaling and decarburizing is supposed to vanish. However, the problem is not so simple, for each different steel and temperature seems to call for a change in the controlled atmosphere. Where temperatures are low and large tonnages of a uniform analysis are put through day after day, as with low carbon sheets, an atmosphere of partially burned gas treated to remove moisture and carbon dioxide seems to have worked out nicely. Of course, with sheets the carbon is so low that decarburization does not have to be considered.

For small toolsteel dies made of air hardening alloys dissociated ammonia seems to produce an atmosphere that is giving satisfactory results. For large dies where a great many hours are required for the slow bringing up to temperature and the long soaking at this temperature, packing in cast iron chips is still in worthy service and is destined to be a part of the picture for some time to come.

"Controlled atmospheres" are receiving a lot of advertising — but go slow. Look at page 254 of "Modern Steels", published by the ASM. It will also do a lot of good to reread the September 1937 issue of METAL PROGRESS.

Salt baths have received much attention in the last decade, and it is now possible to handle many types of steel and at fairly high temperatures in a satisfactory manner; however, for many reasons the size of the product is limited to comparatively small pieces.

Today flame hardening and electrical induction are performing certain operations in a very satisfactory manner, from a non-scaling and decarburizing standpoint, due to the rapidity of the operation.

FURNACE MECHANISMS

By H. H. Harris, General Alloys Co.

As it was in **1915**

MUCH AS THE BARBER fathered the ungentle art of dentistry, so the more enterprising brickmasons in the iron, glass, and ceramic industries, pitting urgency against ignorance, sired the early American furnace.

The master craftsmen in many lines develop a "know how" that isn't read from the blueprints. The men who have put furnaces together with a mounting increment of experience and passed this experience on to their sons and grandsons, deserve far more than a mere workman's part in furnace progress. Today these men are called "Erectors", and each erection adds to their laurels.

Because the brickmason was devoid of scientific mechanics, and the mechanical engineer lacked practical furnace experience, their fields have remained widely separated. The advent of electric heat treating furnaces seems now to be introducing electrical engineers as the first broad influx of technical brains into the furnace industry, yet the application of furnace and alloy engineering of an order comparable with machine design is just beginning.

A perusal of the literature on mechanical furnaces reveals that a wealth of ideas in conveyor mechanism existed even at the turn of the century. Men's minds have been active on the problem of controlling time and temperature by mechanical movement, of reducing the terrific punishment taken by the heat treater who walks up to frying distance of the yawning maw of an open furnace, as it spews out its heat at him and sucks in air to oxidize its contents.

The catch to 99% of the ingenious mechanical furnaces that stuffed the patent office from 1880 to 1915 was that they couldn't possibly work *hot*. Their designers drew up cute conveyor schemes, many of them plausible, or even workable *cold*, but there was no material to make this mechanism from (until the recent casting of high nickel-chromium alloys) except cast iron with a life expectancy somewhat exceeding the proverbial snowball-in-hell. Barring the old "cannon ball" pusher furnaces, brick-lined rotary horizontal furnaces internally fired, slotted hearth and car types, and odds and ends of ingenuity, comprising an infinitesimal part of American hearth area, there are still no "mechanical furnaces". A true heat treating machine is a product for the future.

As it is in **1940**

ALL BRANCHES of the furnace builder's art — refractories, combustion, mechanisms, metallurgy — have progressed geometrically, and the heat treatment of metals is today the fastest developing section of the American "production line" — with a rapidly rising brains-to-mass ratio.

The advent of the high nickel-chromium heat resistant alloys marked the beginning of today's heat treating machine. Rollers and roller rails; link, rotating and shaker hearths, trolleys, chains, beams carry the charge and do the work. Combustion tubes, muffles, retorts, dampers, pyrometer tubes are responsible for good thermal efficiency and atmosphere control.

Unfortunately much is yet to be learned about the effects of expansion, clearances, adhesive and abrasive qualities of oxides, the effects of alternate oxidizing and reducing atmospheres, "creep", "growth", "fatigue" — elusive terms at best, and less definable at variable and intermittent temperatures.

To educate furnace engineers that gear trains, cams and most mechanisms — properly made metallurgically and mechanically — will work, this writer built an alloy clock that kept time at 2000° F., and exhibited it running at the 1928 A.S.S.T. show in Philadelphia.

Today we have successful "hot" roller bearings — "chucking", and individual automatic conveying of parts through all heat treating processes is widely applied. The time is near when no furnace will scale metal. Gears as well as tools and bearings are being fused from powdered metals in furnaces. New cyclic anneals and trick cycle malleableizing furnaces include drastic cooling, even refrigeration. Forced circulation of hot atmospheres with alloy fans has reduced thermal heads and improved uniformity. Many articles assembled from several parts of different metals are now brazed together as a unit on traveling hearths in reducing atmospheres.

"Clean hardening", gas carburizing, oil carburizing, new salt baths are among a score of processes benefiting from mechanical improvements — or stimulating them to competitive development.

Control of movement, atmosphere and heat distribution has been added to control of time and temperature, with the result that the modern furnace — or more correctly, "heat treating machine" — in the hands of technically trained men has so advanced the art and science of heat treating that the heat treat is the strongest and most important link in the American production line.

PYROMETRY

By C. O. Fairchild, C. J. Tagliabue Mfg. Co.

As it was in **1915**

PYROMETRY is a branch of temperature measurement apart from thermometry, and is being practiced by a relatively few progressive men in American industry — and, far in the background, in a few institutional laboratories. The millivoltmeter is commonly used with a platinum thermocouple, and much discussion is heard as to the best way to avoid "cold junction errors". The potentiometer is favored as an indicating instrument, because it has a more open scale and avoids to a large extent the errors of lead resistance. Optical and radiation pyrometers are of course available for higher temperature work.

The standard scale of temperature is fairly well established up to 1100° C. (2012° F.), and a great deal of research work is in progress in gas thermometry and other fields, in an effort to raise this limit. The Bureau of Standards has assigned a special group of workers to this task; notable names are Doctors BURGESS, WAIDNER, MUELLER and FOOTE, and at the Geophysical Laboratory, DAY and SOSMAN. These men will undoubtedly have a profound influence on future progress.

Little is known about how to protect platinum thermocouples; the cheaper base metal thermocouples are therefore coming into extensive use. Perhaps they were not very accurate at first, but industry does not know how much accuracy to demand. Some persons believe that platinum thermocouples are more sensitive to contamination than base metal [now known to be untrue].

A slight modification of on-and-off control for temperature is a notable improvement. Progress here is surprisingly slow, for the GOUY method of throttling control was invented 15 years ago. Only in the most progressive laboratories and industrial plants do we find any appreciable knowledge of automatic temperature control. It is in this field of control, however, that real knowledge of pyrometry is meager. Scientific knowledge of pyrometry seems to be well in advance of the requirements of industry.

As it is in **1940**

TODAY metallurgists lean heavily on the pyrometer, so heavily in fact that we might call it one of their most useful instruments. They have come to learn not only that a thorough knowledge of thermal processes is essential but also that some knowledge of the pyrometer as a tool is indispensable both in scientific research and plant operation. Considering that many alloys are now being heat treated far below a red heat, and that the thermocouple is the most widely used thermometric device next to the mercury thermometer, the term "electrical thermometry" better suits the art.

Electrical recorders and automatic controllers are now commonplace in industry, and precision potentiometers and bridges in laboratories. The modern scientist is inclined to relegate temperature to the classics, while the practical engineer of 1940 demands the utmost in accuracy and performance.

The international temperature scale is well established to ranges far above the needs of industry. In the larger industries we find many processes in plant practice fairly well coordinated and standardized as to temperature.

Interest in temperature measurement and control is very widespread. It is well known, however, that there is room for tremendous improvement not only in the practice of heat treatment but in our scientific and practical knowledge of temperature and how to measure and control it. Practical progress will depend to a large extent on how much engineering is to give way to modern trends in management.

The recent symposium on Temperature, its Measurement and Control in Science and Industry, ably recorded the present status of electrical thermometry. A fuller picture of the industrial situation might have been possible. It is not recorded that potentiometers are now used almost to the exclusion of millivoltmeters, that every metallurgical laboratory and heat treating furnace is equipped with means for temperature measurement and/or control, and that a new heat treating process is being developed with almost weekly regularity.

HARDNESS TESTING

By Stanley P. Rockwell; The Stanley P. Rockwell Co., Inc.

As it was in **1915**

AMERICA is getting well started on its first big war industries job, not for ourselves, but on orders from the Allies. Since our Civil War ended 50 years ago, it has been recognized that on both land and sea war has become a matter of mechanism as well as of men. Even that mechanism itself must now be thought of as a matter of metallurgical science as well as mechanics, as is becoming widely recognized in the armed services and in the plants engaging to construct the metal skeleton of the anatomy of war.

Measurement of the hardness of metal and its useful interpretation has been receiving more and more attention, both with regard to testing raw stock for its adaptability to stamping, forming and machining, and with regard to testing parts for their suitability or durability. The word "durability" comes from the Latin "durus", meaning hard. Frequently greater hardness does result in greater durability, but many tools and machine parts may be so hard as to suffer from brittleness, and may in service actually break and therefore have less real *durability*. That is just an obvious example of what the metallurgist must not only be alert to, but is an example of what he must give a lot of time and study to also; namely, the wise and safe interpretation of hardness measurements.

We have now available several useful hardness testing methods and instruments, but they are mere tools and furthermore are tools that must be used with discretion based on the experience of oneself and upon the experience of others. So few hours does the active life of any one man comprise, that we must all record and publish what we learn in using hardness testing apparatus so that useful and dependable data may be established, and which we may all use freely and modify to meet individual needs and conditions. But let this data in the future be carefully prepared and checked and laid open to criticism for the purpose of insuring its soundness.

As it is in **1940**

HARDNESS TESTING is one of the established practices in metallurgical laboratories and heat treating departments. Many manufacturing blueprints are as definite in specifying the required hardness of parts as in dimensioning their size. Means now exist for testing hardness at all sorts of depths. Forgings and heavy bars are tested with large ball penetrators and heavy loads, with optical or mechanical measurement of indentation. Non-ferrous sheet and moderate size pieces are tested with smaller balls and lighter loads. Hardened steel is tested with diamond indenters. Nitrided steel and thin metal sheet are tested with still smaller loads and suitable penetrators. Resistance to scratch is used as a hardness measure in certain special instances. In other cases the magnetic properties of the steel have been correlated with hardness.

Large organizations have established hardness specifications for the guidance of their own operations in making parts and also for many typical tools and standard parts, which data have been published for the benefit of smaller companies who, now that there are universally recognized hardness scales, may and do make use of such published specifications.

Hardness, as it is measured, is probably always a combination of several physical properties. The deep drawing characteristics of sheet metal are not fully disclosed by a hardness test, but hardness values considered together with other tests or with the knowledge of chemical composition serve widely as a useful guide in press shaping of sheet metal.

The most notable things about hardness testing are first, the desire and demand for high precision in testing and second, the advance to a position of positive guidance in place of merely being a general and occasional indicator to assist the trouble shooter or research man.

MECHANICAL TESTING

By R. L. Templin, Aluminum Co. of America

As it was in **1915**

THE TESTING ENGINEER is very much concerned about the details of suitable methods for making tension, compression, and hardness tests. There is no general agreement on dimensions for tensile test specimens and no satisfactory specimen or method for thin sheet metals. Definite progress is reported on the international acceptance of a standard test bar for cast iron. There is much confusion regarding the definitions of terms such as "proportional limit", "elastic limit", and "yield point". "Johnson's apparent elastic limit" is much favored by some testing engineers.

It is believed that variations in speed of testing, within the limits encountered in practice, affect the values obtained for yield point and tensile strength. Consequently, until certain investigations have been completed no decision can be made as to the proper speeds for testing. The design of extensometers is receiving much attention and there seems to be a pronounced difference in opinion as to whether it should measure strain on three or on two elements of a round specimen.

Fatigue testing is still in its infancy although Wöhler's historic tests were made many years ago. Very few, if any, fatigue tests have been carried out sufficiently far to determine the endurance limits of metals. Several railroads have included a vibratory test for staybolt iron but, lacking a standard method of testing or a standard type of machine, mutually agreed upon, disputes about the results are common.

Impact tests are being made at Watertown Arsenal, limited mostly to Charpy tests. Results appear to differentiate between steels having various degrees of brittleness.

The War and its demands for materials emphasize the necessity for standardization of testing methods so that various laboratories can obtain comparable results. The need for better testing apparatus is appreciated. Standard methods for carrying out the Brinell hardness test are in the process of being adopted, and the scleroscope is used by many industries for checking the hardness of metals.

As it is in **1940**

MANY OF THE PROBLEMS which confronted the testing engineer 25 years ago are still unsolved. Much progress has been made in establishing satisfactory methods of testing. Definitely better testing machines, extensometers, and auxiliary apparatus are now available, and agreement has been reached on most of the nomenclature. Tensile tests of thin sheet metals are now made by the ten-thousands, in accordance with recognized standard methods. Speed of testing has rather wide limits and is still under investigation.

The autographic extensometer has come into general use for routine tension testing. By the use of such apparatus it is now possible to obtain close agreement in yield point and yield strength among different laboratories.

Fatigue testing is being done by many laboratories, scattered throughout the country, equipped to make various kinds of tests. Endurance limits of many of the commonly used metals are now well known. The fatigue resistance of riveted and welded joints and of structures is being investigated. While the Charpy and Izod impact tests are still used, the tension impact test is being recognized as of more value. Impact tests of built-up structures have become more common. The Rockwell hardness tester has come into general use, and many combinations of penetrators and loads are recognized as standards for various purposes.

In general, there is greater uniformity and less controversy between producer and consumer because of standardized methods and procedures for routine testing. Calibration devices as well as standard methods of calibration are now in general use for testing the apparatus. These have served to narrow the limits of error in commercial test results.

The effects of creep, the damping characteristics of materials, and the behavior of built-up structures under static and dynamic loads are perhaps the most outstanding problems confronting the testing engineer today.

CORRODING TESTING

By R. M. Burns, Bell Telephone Laboratories

As it was in **1915**

IT IS REPORTED, although not as yet confirmed, that the addition of small amounts of copper to ferrous metals improves their corrosion resistance. This contention will be tested by comparing specimens of steel and iron containing from 0.15 to 0.30% copper with similar ferrous specimens containing no added copper when the two series are exposed for an indefinite period to the atmosphere in seacoast, rural and industrial localities.

While it is recognized that the only final test of the corrosion resistance of metals and metal coatings is to be found in their behavior under service conditions, the early need of engineering information requires the use of more rapid chemical methods. It is therefore common practice in corrosion testing to compare the rates of loss of weight of metal specimens when immersed in acids and salt solutions and judge corrosion resistance on this basis.

More recently a new test known as the "salt-spray" test has been proposed as a suitable method of appraising the corrosion resistance of metals and the protection offered by metal coatings. It is said by the proponents of this test that it accelerates the conditions of marine or sea-shore use. In cases where the synthetic "salt fog" employed in this test is too drastic a plain water spray may be substituted. This test is very searching and should be a most useful tool in the evaluation of protective coatings; it might even furnish guidance in the development of metals resistant to all natural conditions of exposure.

As it is in **1940**

IT IS NOW RECOGNIZED that accelerated corrosion tests cannot be relied upon to furnish dependable information of the corrosion resistance of specific metals under specific conditions of use. Consequently tests of this type have been abandoned with the exception of the salt-spray test which is now used largely as a means of comparing the quality of different samples of the same or similar materials.

Comprehensive atmospheric and soil exposure tests in recent years have yielded significant information upon the corrosion resistance of nearly all important commercial alloys and metallic coatings. A great variety of field tests (atmospheric, soil, water, chemical in character) are now carried out in the actual environments in which metals are to be used or under conditions which simulate these environments as closely as possible.

In the metallic coating field standards of quality are employed which are based on the measurement of the coating —its thickness, uniformity and continuity.

An increasingly larger proportion of the effort in the field of corrosion testing is being devoted to chemical and electrochemical studies of the actual corrosion processes. In this work refined techniques are employed which are capable of following corrosion reactions as these occur under natural conditions. Undoubtedly the accumulating knowledge of the nature of corrosion will make it possible to devise more and more effective methods for its control at a reasonable cost, even though the requirements of use seem to grow continually more exacting.

MICROSCOPY, RADIOGRAPHY

By S. L. Hoyt, Battelle Memorial Institute

As it was in **1915**

SINCE THE TURN of the century metallic microscopy has become an established tool of the metallographist. The inverted stand of LE CHATELIER is gaining favor on account of its simplicity. From various sources the superior qualities of the apochromatic lenses have been noted. One labor-consuming problem exists: In order to do a fairly respectable job, the polishing must be done by hand; in general the technique of sample preparation all along the line is scarcely adequate. On account of these factors the currently made photomicrographs, more frequently than not, are but poor representations of the metal structures. In spite of this, metallic microscopy is very highly regarded by metallographists but does not carry the weight it will eventually have with others.

The use of X-rays in metallurgy is an interesting innovation that has much to recommend it. So far it is a research tool that has scarcely obtained more than a start, WHEELER P. DAVEY who has recently joined the research laboratory of General Electric Co. being the principal American exponent of X-ray radiography.

Little or no diffraction work, following the methods developed in a few foreign physics laboratories, notably by LAUE in Germany and the BRAGGS in England, has yet been done in America. The startling announcement has been made that the sodium chloride crystal is built up of alternating sodium and chlorine ions on a cubic lattice. This statement, if a fact, will dismiss for all time the notion of a simple sodium chloride molecule as the structural unit. To the metallurgist such work has the possibility of determining the actual structure of metals, and of settling the controversy as to structural and phasial differences between alpha, beta, and gamma iron. However, the use of X-rays in metallurgy has done little as yet other than stimulate the imagination.

As it is in **1940**

LET US LOOK to *results* as evidence of the changes that have taken place in 25 years: New methods of polishing and mechanization, a greater diversification of etching methods, improved microscopic equipment and better photographic facilities, and an appreciation of the correct way to utilize all these facilities have all contributed to the vastly improved status of the science of metallography. This applies particularly to the present high quality of photomicrographic reproductions, and for the simple, though fundamental, reason that the metallurgist, engineer and executive now secure clear cut and unambiguous pictures of metal structures. Happily, questions as to just what it is that a photograph is supposed to show are but infrequently raised. For this we have to thank such pioneers in quality work as LUCAS and VILELLA who were mainly responsible for raising the standards all along the line. This is the outstanding feature of the past 25 years' work in metallography, restricting the word to its literal (if somewhat narrow) meaning.

X-ray equipment is now standard in many metallurgical laboratories. Many production welds and castings must pass X-ray acceptance tests and certain phases of foundry practice are controlled by radiographic findings. Even the somewhat similar radiation obtained from radium or a derivative is used in commercial work. It is no longer necessary to rely on the surface appearance of a structure for evidence of internal soundness, nor is it necessary to section a part, thus destroying the sample. The use of X-ray diffraction patterns has revolutionized our concepts of the structure of metals and alloys and has thrown new light on the processes of plastic flow, recrystallization, transformation of phases, and directional properties in metal. Incidentally, beta iron has disappeared as a separate phase, and as the source of the hardness of quenched high carbon steel. Diffraction of electrons has already given us useful information on the conditions at the very surface of metals.

ALUMINUM

As it was in **1915**

THE WORLD'S PRODUCTION of aluminum increased nearly ten-fold in the past decade, and last year (1914) reached the figure of nearly 85,000 metric tons. This is nearly 9% of the World's production of copper (932,000 metric tons) or 10% of that of zinc (862,000 metric tons). Among the relatively new uses for this metal may be mentioned aluminum foil and aluminum bronze powder, for which a plant has recently been erected in the United States. Sheet of pure aluminum and the aluminum-manganese alloy known as 3S has been available for years, and these materials have recently been made available in the form of extruded moldings and drawn tubing. The automotive and cooking utensil industries are among the most important consumers.

An important use for high purity (99.5%) aluminum seems to be developing in what is known as "aluminum cable steel reinforced", over 12,000 miles of which have been erected in the United States for the transmission of electricity at high voltages.

In this country, nearly all aluminum alloy castings are now made of No. 12 alloy (containing 8% of copper) or other alloys of similar composition, although there are still some castings made with the alloys containing zinc, which, in spite of their inferior corrosion resistance, are extensively used abroad. Aluminum pistons and similar small castings (not larger than would go into the proverbial "cocked hat") are being made by the permanent mold process.

It is reported that a heat treated alloy called "Duralumin" is being manufactured in Germany and used experimentally for aircraft, and that some has been produced experimentally in England. It is alleged that this alloy has nearly the strength and ductility of mild steel, but these claims and those of the commercial production of such an alloy require substantiation.

As it is in **1940**

THE LATEST PUBLISHED FIGURES (1938) show a world aluminum production of over 538,000 metric tons; about 27% that of copper, or 34% that of zinc.

While pure aluminum and 3S sheet are still produced in large amounts, the heat treated "strong alloys" of aluminum now comprise about one-third of the total sheet production. Relatively little of this has the composition of the original Duralumin; practically all of that used in the aircraft industry is of a considerably stronger and recently developed alloy, while a variety of other new heat treated alloys of various strengths and workabilities are manufactured in all commercial forms, particularly for the transportation industry. Large and complicated extruded shapes and rolled structural shapes up to 12-in. channels 85 ft. long are now produced of these strong aluminum alloys, and used in busses, cars, and bridge floors.

Aluminum is largely used for foil and collapsible tubes, as for toothpaste, and the production of aluminum bronze powder and paste for paints runs into millions of pounds per year. The amount of "aluminum cable steel reinforced" erected in this country will pass the 900,000-mile mark this year.

Aluminum is making real headway in the chemical and beverage industries, particularly for containers, tank cars, and large storage tanks. To torch-welding, there have been added electric arc-welding, spot-welding, and seam-welding, as well as brazing.

In the foundry, the old No. 12 alloy continues to be used widely but has been supplemented by a large number of modern alloys, including those containing silicon and magnesium as well as copper. Permanent mold casting and die casting have developed tremendously, and heat treated aluminum alloy castings have become common articles of commerce.

Forging of strong aluminum alloy propellers, pistons, crankcases and fittings for aircraft has become an important industry.

MAGNESIUM

By John A. Gann, Metallurgist, The Dow Chemical Co.

As it was in **1915**

THE YEAR 1915 has witnessed the birth of our American magnesium industry. Prior to this date, domestic requirements were met by importations from Germany, but demands were small as the metal cost about $1.65 per lb. and known uses were very few. The War has suddenly changed the picture. Importations have ceased, while Government requirements for military purposes are rapidly increasing. This impetus has been sufficient to cause many to investigate the problem of commercial manufacture with the result that by the close of 1915 there are five American producers of magnesium. The total output for the year, however, is less than 100,000 lb., valued at a little more than $5.00 per lb.

[During the next few years, all five of these original producers disappeared from the picture while other names came and went. Although by this time the price of magnesium had dropped to about $2.00 per lb., this price was still very alluring. The industry became stabilized when companies entered the field with a long term vision based on the economic evaluation of raw materials and a basic research program directed toward a peace-time industry.]

The 1915 uses for magnesium are extremely limited. The average individual knows of the metal only in the form of flash-light powder. Government requirements are based on the dazzling white light emitted when the metal burns and the dense, pure white cloud of magnesium oxide forms, thus adapting the metal for use in signals. The metal is likewise used to a limited extent for the deoxidation of nickel and to improve the properties of aluminum.

It is possible that magnesium may have a history somewhat parallel to that of aluminum and become adaptable for the manufacture of articles of greater or less size; speculations on the future are abundant but its true destiny is unknown.

As it is in **1940**

THE LAST quarter of a century spans a new industry from the date of its birth to an important position in American life. The significant features of this development have been the steadiness of growth, independent of depression cycles, and the increasing diversification of other industries now dependent on magnesium.

Magnesium alloys have been developed with properties to fit them for a wide variety of uses, available in all the forms required of an engineering metal, such as sand castings, die castings, structural and special shapes, bars, rods, tubing, and sheet. Heat treating, forging, forming, welding and related fabrication and assembly operations are standard commercial practices. Finishing operations have been perfected including chemical finishes, anodizing, coloring, and painting. In short, magnesium alloys have become a member of our family of engineering metals.

Growth has closely followed these technological advances. Lightness has been and still is the dominant characteristic of magnesium alloys. It is not surprising, therefore, that the aircraft industry should have been one of the early users of these ultra-light alloys and that the tremendous growth of this industry, coupled with the increased proportional amount of magnesium alloys in each plane, should have been a great impetus to the magnesium industry, not only here but in all other phases of transportation. Office and household equipment, portable tools, as well as the machine industry, have likewise benefited where weight-saving would result in new economies. Increasing quantities of magnesium are also consumed in the refining of various metals and in the production of aluminum alloys.

Concurrent with this growth in volume has been the decrease in metal cost. Magnesium is now sold for about one twentieth its 1915 price. Its alloys, competitive with other metals, are widely known as "Dowmetal", "Mazlo", "Magalloy", etc., and are available in quantities sufficient to meet all demands from foundries and fabricators throughout the country.

NICKEL

By Paul D. Merica, The International Nickel Co., Inc.

As it was in **1915**

World production of nickel made a new "high" of about 45,000 short tons, of which a considerable proportion was used in nickel alloy steel armaments such as armor plate, guns and projectiles.

Otherwise the principal uses of nickel are for industrial nickel alloy steels, nickel silver and cupro-nickel and nickel plating. Invar and Elinvar, Monel Metal and the chromium-nickel-iron electrical resistance alloys are interesting new alloys, only a few years old, whose future importance is problematic.

As to methods of production, metallic nickel (99% purity) is available chiefly in the form of ingots, shot and pellets and in rondelles; electronickel cathodes are in limited production only.

Monel Metal and malleable nickel in rolled forms are produced in small quantity, largely in brass, copper or steel mills devoted to tonnage production of other materials.

Comment, past and present, on many of the nickel products of steel mills and foundries, brass and copper mills, brass and bronze and iron foundries, will be found in other sections of this review.

As it is in **1940**

World consumption (in 1939) reached a new "high" at about 125,000 short tons, of which only about 15% was used in nickel alloy steel armaments.

Nickel alloy steels for many diverse industrial applications account for some 60% of the total nickel, and, in addition to older industrial uses, are many newer irons and steels including particularly stainless steel, various types of nickel alloy foundry iron products, the group of magnetic nickel-iron alloys of high permeability, as well as the still more recent permanent magnet alloys of the "Alnico" type.

Electronickel (cathodes) of 99.90% purity have largely replaced ingot and shot nickel and constitutes more than half of the world's production; Mond pellets and rondelles are still produced; nickel powder has in recent years come on the market.

Monel, malleable nickel, Inconel and many other special high nickel content alloys are principally produced in mills designed and devoted exclusively to the production and fabrication of these products. These metals are likewise also available today in clad plate used for large units in chemical equipment, wherein the thin nickel lining resists the corrosion and the thick steel backing resists the pressure.

Malleable age-hardening alloys of nickel and of copper-nickel are on the market including particularly "Z" nickel and "K Monel". Similar ones of chromium-nickel and of chromium-nickel-iron are known, these alloys yielding, in the heat treated condition, tensile strengths over 150,000 psi.

Molybdenum-nickel alloys are in industrial use today exhibiting special corrosion resistance characteristics of value. Hard silicon-Monel foundry alloys are filling many of the more severe requirements of engineering design.

Pure nickel coinage, although introduced in 1881, has spread widely and has been issued in 34 countries.

COPPER & BRASS

By W. R. Webster, Bridgeport Brass Co.

As it was in **1915**

FROM THE TIME that the brass industry was born in the United States up until the second year of the War, manually-fired and oil-burning pit furnaces had been used for making brass and other copper base alloys. As a matter of fact, the old coal-fired pit furnaces and crucibles had been in use since the Middle Ages and it was not until 1916 that the casting of brass, the most important step in the whole manufacturing process, was put on a scientific basis.

In October 1916, after years of investigation in its own laboratory and additional study in conjunction with outside furnace companies, Bridgeport Brass Co. installed two electric casting furnaces using as the heating element the induction unit invented by J. R. WYATT. These were the first electric furnaces to be used in the brass industry. [They proved so successful in operation that the Company later scrapped its pit furnace casting shops, installed all electric furnaces and built the first casting shop without a chimney.]

The electric furnace method of melting and casting the copper alloys is attracting the keen interest of practically all of the manufacturers in the industry, for the development seems to provide advantages not only in the casting shop but all the way through the mill to the finished product. Among the immediate advantages that comes with the electric furnace is the production of brass of a uniform and definite quality which can be produced time and time again as desired. Its ability to provide better and heavier castings of various types may conservatively be expected to foreshadow many changes in mill equipment.

Thus, during the War years, one of the most important contributions to the progress of the brass industry seems to have been developed.

Larger and more powerful extrusion presses are continually expanding the field of application of this method for the production of rods.

As it is in **1940**

AS IT WAS at the turn of the 19th century, and as it was in 1916, the brass industry today in centered in Connecticut. Its growth from brass buttons in the beginning to the highly finished precision products of today has been steady. Connecticut brass manufacturers produce annually materials valued at more than $95,000,000, and account for approximately half of the nation's brass mill products.

Recent developments, many of which spring from the electric furnace method of melting large charges (up to 1200 lb.), are to be found in larger, mechanized mill equipment which reduces the art of metal working to a practical science. Four-high mills set in tandem reduce the slab in fewer passes to products of more accurate gage; new billet heating furnaces with automatic temperature control, as well as special annealing equipment where the determination of grain size is a matter of setting a hand and pushing a button, insure a product that is more uniform in every way than the metal of 1916; tailor-made conveyor systems, handling equipment and many other innovations, reflect a picture of the industry today.

The recent successful application of the continuous casting method marks an improvement which in its ultimate results may well equal those which followed the introduction of electric melting.

Little improvement in methods of producing rods has taken place beyond that incident to the use of electric melting and more accurate process control, since the extrusion methods had been previously perfected as far as the production of rods was concerned. Marked improvement in the application of extrusion presses to the manufacture of seamless tubes has, however, taken place in the last few years.

In addition to these improvements in equipment and methods of control, a number of new alloys have been developed. Among these may be listed cupro-nickel and aluminum brass for condenser tubes, and the silicon bronzes. Mention should also be made of the age hardening alloys, the most valuable of which are those employing beryllium.

ZINC

By E. H. Bunce, The New Jersey Zinc Co.

As it was in **1915**

Production of spelter in retort furnaces made up of a row of small individual retorts is an art involving a multiplicity of details to which careful attention must be paid. Progress in zinc metallurgy therefore may be expected through improvements in minor details rather than radical innovations.

Spelter is in a very advantageous position but the shortage of labor to man the retorts and the danger that the high price may so limit domestic consumption, particularly in galvanizing, as to partly offset the increased foreign demand, are causing the industry some concern.

Corrosion of the retorts limits the ores to those in which the zinc mineral can be concentrated by magnetic separation, jigging or tabling. Sulphide ores are roasted in externally fired kilns and the SO_2 converted into sulphuric acid. The average production of spelter per retort per day is about 25 lb.

The grade of the spelter produced is determined by the impurities in the zinc concentrates. The lower grade, or common metal, is largely used for galvanizing. The intermediate grades are used for rolling into sheets and for alloying with copper to make bronzes and brasses. A limited tonnage (about 18,000 tons) of high-grade spelter, 99.95% Zn, is produced from ore bodies which are sufficiently free from lead and cadmium. This high-grade spelter is used mainly in cartridge brass. A small poundage of zinc of a purity of 99.993% has recently been produced and used as a laboratory reagent.

The chief technical problems of the industry, besides the main one of producing enough spelter to keep up with the market demand, are the roasting and smelting of the extremely fine concentrates produced by the new flotation method; the effect of cadmium as an impurity in cartridge brass; new fields of use in the peaceful arts to replace wartime demands; and the development of the electrolytic and other processes for the production of high-grade zinc from complex ores.

As it is in **1940**

Zinc is now commonly called zinc, and not spelter, and in its own name has acquired a metallurgy that puts it on a technical basis rather than an art brought over from Europe. Progress in pyrometallurgy has kept pace with the electrolytic process, and both have attained an objective thought, only a few years ago, too fantastic to consider seriously. Large tonnages, 220,000 tons in a year, of high-grade metal mostly of a purity of 99.99+ Zn, are being produced by the electrolytic process and by a pyrometallurgical refining process. This has opened up new fields of use. The common impurities, particularly lead and cadmium, have been reduced to so low a figure that they no longer play any part in limiting the usefulness of zinc metal; these impurities are so low that spectroscopic analysis alone can quickly and accurately determine them.

The flotation process has made available for smelting many deposits otherwise not workable. Fire concentration by the Waelz kiln recovers much zinc from low-grade ores and residues. Sulphide ores are largely roasted autogenously and flash roasting is used extensively.

The old horizontal retort process has been improved by using high-grade flotation concentrates prepared by sintering, which together with improved retorts have brought the average production per retort per day to about 60 lb. However, the old process is being supplanted by vertical retort, electrolytic and electrothermic processes. A continuous pyrometallurgical refining process employing the principles of rectification produces high purity metal regardless of the impurities in the ore.

The development of new alloys of zinc based on the high purity metal has resulted in a new field of zinc alloy die castings which last year used over 100,000 tons of zinc.

There are many economic problems facing the industry, but the main technical problem appears for the time being to be one of improving and developing high zinc alloys rather than radical processing changes.

LEAD

By Albert J. Phillips, American Smelting & Refining Co.

As it was in **1915**

IN AN INDUSTRY that is centuries old 25 years is a short period of time. In this year of 1915 the lead industry is moving along at an even gait, producing a half-million tons yearly at a price approaching 5¢ — not very different from conditions existing for many years.

The quality of the product is for the most part very high, even as compared to chemical standards, for lead has always been a metal that has been produced in a remarkably pure state. In this respect it resembles the precious metals silver and gold rather than the base metal iron.

The uses for lead are likewise very little different from the uses at the turn of the century. Possibly there is a little more emphasis on "ammunition" and less emphasis on "storage batteries", but the difference is merely in degree. A considerable amount of lead is being used for electric cable sheath, and this bids fair to be an important outlet. Possibly too, the chemical resistance of lead is not attracting the attention of chemical engineers that it deserves but, even here, the lead-chamber process of making sulphuric acid, one of the first tonnage chemical industries, is an "old" industry, even in this year 1915. In fact, superficially, the lead industry appears pretty much the same in 1915 as it has always appeared.

As it is in **1940**

THE OUTSTANDING TREND in the lead industry today seems to be towards the development control of added elements for special purposes. Now detailed studies have demonstrated the effects of elements in the second, third, and even fourth decimal place and the importance of many elements, formerly regarded as impurities, is now well established. For example, special combinations of elements are now considered desirable by those making the pigments white lead and litharge and the other lead compounds where formerly the demand was entirely for high purity. For purposes where "just lead" was formerly specified and used, lead alloys are now demanded which contain only a few hundredths of a per cent of elements that were commonly regarded as impurities, such as copper, tellurium, silver, bismuth, cadmium, arsenic, and antimony. In fact, it is now almost impossible to find an "impurity" in lead that does not impart some desirable physical or chemical property for at least one special purpose.

Consequently the production of lead in 1940 is a highly specialized field producing special "leads" for many purposes. It can almost be said that the average lead refinery produces a range of lead alloys today rather than "just lead".

BLAST FURNACE SMELTING

By Walter Mathesius, U. S. Steel Corp.

As it was in **1915**

THE 405 coke blast furnaces and 40 charcoal blast furnaces in existence today have an annual capacity of 45,000,000 gross tons. Average daily capacity of coke furnaces is approximately 325 tons, and the largest daily production of a single furnace is approaching 600 gross tons.

Coke rates of individual furnaces producing standard iron grades, excluding the Southern Districts, range between 1750 and 2600 lb. per gross ton. Average for the industry is slightly above 2000 lb. per gross ton of iron produced. The greater portion of coke is produced in beehive ovens.

Hearth dimensions are increasing, due to recognition of the fact that small hearth volumes and constricted bosh designs are impediments to greater and more uniform production. Some daring designs show hearth diameters up to 17 ft.

Most plants are producing iron with a sulphur limit of 0.050% and under, and in many cases, only 20 to 30% of the total pig iron production is above that figure.

Ores from the Mesaba range are gradually replacing Old Range ores, although considerable difficulty is being encountered in some cases, due to the greater physical fineness of the former.

Uniformity in composition and physical character of the raw materials leaves much to be desired, and these features are beginning to receive attention as major causes of irregular furnace performance with many hanging, slipping and otherwise hazardous periods. Stock charging facilities and furnace top equipment are designed mainly as a means of conveying the required quantities, with little regard to the effect of these features upon the manner of stock *(Continued on page 352)*

As it is in **1940**

THE 232 coke and four charcoal furnaces standing at present have a combined annual capacity of over 50,000,000 gross tons. The average daily capacities of present coke furnaces is about 625 tons. Maximum daily output of large modern furnaces is over 1200 gross tons.

Present coke practice ranges between 1600 and 2000 lb. per gross ton of iron produced, excluding the Southern Districts, and the industry average is approximately 1800 lb. By-product coke only is used, except during periods of peak demand.

Hearth diameters of less than 20 ft. are exceptional and furnaces with 27-ft. hearth diameter are in successful use. With stack profile and volume increased in due proportion, larger outputs are being obtained with good economy.

Sulphur limits have been lowered in many cases to about 0.030% and pig iron quality is no longer a major problem in the regular production of high quality steels.

Mesaba ores are used exclusively at many plants.

Careful grading (and sizing, where required) of raw materials is now a standard practice, as is the constant control of coking coals, coke making, sizing and screening for uniformity of fuel values charged into the blast furnace. Stock distribution and stock descent are appreciated as being the primary factors regulating the gas-solid contact in the furnace stack, thus largely governing the effectiveness of ore reduction and the over-all economy of the process. The McKee revolving distributor has become universally adopted as almost indispensable for modern, efficient iron smelting. Studies of gas flow, temperature and composition at *(Continued on p. 353)*

OPENHEARTH

By F. L. Toy, Homestead Steel Works, Carnegie-Illinois Steel Corp.

As it was in **1915**

DEMANDS of customers, old and new, domestic and foreign, are pushing us into new fields of endeavor in the manufacture of basic openhearth steel. Our acid furnace associates and the few naval ordnance steelmakers have trod these paths before us, but now the basic openhearth men, proud in their feeling of superiority over the bessemer men, have a job of making alloy heats, of working on steel that will meet the demands of the shell and gun makers.

Such grades are as yet a small part of total production, but it means that some of us must definitely improve our technique. There must be better control over melting conditions; efficiencies of alloys must be learned (they cost money); a close control of heat analysis involves a study of ways and means for the deoxidation of the bath. A closer control of pouring temperatures will follow the use of optical pyrometers, now beginning. We must learn what causes segregation and piping from the worthwhile experiments now under way; take more care in pouring practice and mold preparation; develop hot tops, study the mold contour and its distribution of mass; check samples from various steps in the process under the microscope to see what factors influence the increase or decrease of inclusions; learn the effects of deoxidizers in ladle and molds on the quality of the finished steel.

All these are new and real obligations; the products are relatively more costly and we must conserve them, all in the interest of having our process contribute new kinds of service to the customer at not too high a cost.

We are looking to the 100-ton furnace as a practical tool, combining many desired advantages. Operators of smaller furnaces would like to have some of its cost advantages, so we scheme to get more tons per square foot of hearth area. It means burning more fuel and it means better draft to get the gaseous products out through the flue system.

An openhearth man is always being prodded —there are so many new angles!

As it is in **1940**

BY REPUTATION there were real artists in steelmaking 25 years ago, but for "repeats" on definite qualities the story changes today. We have a much better understanding of steel processes and products, with numerous "controls" developed by necessity in the last decade. Codes for openhearth control, from known results in customers' shops, give the steelmaker a clear picture of the best moves in the critical phases of refining. Slag pancakes, "V"-values, tie-in with lime control, FeO lower after melting, basicity increased in the right phase — all have their meaning. "Qualities" (grain size, aging characteristics, coarsening, inclusion counts, and others too numerous to give) issue forth as characteristics through process control. Intelligent "follow up" furnace design, draft control, roof and checker temperatures, fuel and air proportioning, help to "tool" the melting shop for quality, production, speed and furnace life. Refractory makers have matched the pace with refractories to withstand the longer refining and higher temperature. "Iron oxide in the bath" (with correlation still not so good with FeO in the slag) reveals itself in more consistent manner by bomb molds and electro photometers. Bath pyrometry is now a "tangible", and checks the old reliable "indications".

Stationary furnaces of 175 tons or greater are economical, dependable units making steel of good quality. Bogie for fuel (5,500,000 gross B.t.u. per gross ton in 1915) is now 3,500,000; 9 tons per hour has advanced to 17.

Many factors in openhearth melting and refining are now calibrated — *but* — the metallurgist and steelmaker must not fight the battle for process control on too long a front. Remember the important reactions first and foremost in any study and application. Modern production control, which is setting up the pattern of the customer requirements in quality and delivery, must develop to comply with definite standards of service to the steelmaker, so that variations will not defeat skillful operation, lose effort and time, and produce high costs.

BESSEMER PROCESS

By H. W. Graham, Jones & Laughlin Steel Corp.

As it was in **1915**

DURING THE LAST DECADE (1905 to 1915), the bessemer process of steel making has lost considerable tonnage to other steel making methods for certain applications that were largely pioneered by it. The production of steel for rails, for example, long produced by the bessemer process, has declined till now only a small proportion of bessemer steel is used for this application. Aside from this use, however, the production of converter steel has actually increased about 18%. The fact that last year (1914) over 6,000,000 tons were produced in the converter and over 17,000,000 tons in the openhearth does not describe the full utility of the bessemer plant, for much of the openhearth steel was made by the duplex process, which requires the use of molten metal partly refined in the bessemer converter.

A large amount of the bessemer's lost tonnage is the result of a prejudice that has arisen against bessemer steel. Many former users of its products are now specifying openhearth steels — not because they have a knowledge that it is a better steel, but simply because it appeals to them as being on the safe side. If this prejudice does not spread further, the bessemer process stands in good way to gain back a considerable share of the expanding markets for steel products.

As far as the decarburization of iron is concerned, the bessemer process leaves little to be desired. However, one weakness of the acid converter process used solely in the United States has been its inability to eliminate sulphur, and, more important, phosphorus. Work is being done at present with additions of fluoride compounds to reduce the proportion of these elements originating in the pig iron. If successful, this may be the force to combat the prejudice against bessemer steel in a market rapidly being expanded by the impetus of the present European conflict.

As it is in **1940**

ONE OF THE MOST PRONOUNCED TRENDS in the steel industry has been the recent widespread attention given to the bessemer process of steel making. In the span of only several years, it has become an object of metallurgical investigations that promise to elevate it to its proper important place in the industry.

It is beginning to be realized that the very simplicity of the bessemer process (which was once thought to be a handicap) may be an advantage in producing quality steel. The metallurgist, with extensive experience gained in openhearth control, and equipped with recently developed scientific instruments, is turning this advanced position to bear on the bessemer process.

Scientific instruments based on photocells have been applied to replace human judgment in determining the proper endpoint of the blow. The degree of oxidation of the blow can be set to predetermined close limits, facilitating the production of a uniform quality of steel, blow to blow. Temperature control is more thoroughly understood, and is being successfully applied.

Dephosphorizing and desulphurizing, long realized as an impotency of the process, have been achieved. One company is reported to be organizing for application of the PERRIN process. Recently, the conditions which affect the absorption of nitrogen have been studied. When control of this element is accomplished, it will have a great effect on not only the bessemer process, but on the duplex method, in which the bessemer is so important.

In addition to advances in this country, this new trend extends to England, India, Japan and the Continent, resulting in a greater use of the bessemer steel making unit.

In the short time that this new turn in the history of the bessemer process has been in evidence, many important developments have been initiated that assure its return to greater importance in the industry. It appears, therefore, that a new era of usefulness is in prospect for the bessemer process.

ELECTRIC FURNACES

By Earle C. Smith, Republic Steel Corp.

As it was in **1915**

"So you're Bill Farnsworth, the chemist? Well, 'Nig' Clark told me this furnace was working so fast they couldn't wait to send 'prelims' to the lab; just had to move the lab onto the floor."

"Well, we do have to work fast. That last heat only took three hours."

"Of course, you start with hot metal from the openhearth; but still 'Nig' said it took only an hour more to clean up straight bessemer metal."

"Four hours is about right! And at the rate they're putting in these electric furnaces I suppose I'll be more of a furnace man than a chemist before very long."

The furnace referred to is the 15-ton Heroult at the South Chicago plant of the Illinois Steel Co. It and a similar furnace in Worcester (American Steel & Wire Co.) are the largest electric arc furnaces in the world. They are each three-phase units with electrodes spaced in an equilateral triangle. Each phase has a special 750-kva. transformer, making the total power input 2250 kva. at 110 volts. Equipped with several taps from about 75 volts, the transformers have already demonstrated that this is by no means the limit for three-electrode furnaces. Twelve-inch graphite electrodes are preferred when they can be obtained.

The furnace at South Works is making special carbon steel, such as special rail steel, and alloy steels such as Krupp made famous, particularly the low carbon 1% chromium, 4% nickel steel for casehardening, and also steels with 1½% chromium to replace the Swedish acid openhearth and crucible steels which are no longer easily obtained.

The trend in electric furnaces is definitely toward the Heroult type. There are now 18 in the United States, 19 in Germany, and 37 more in the rest of the world. Under construction in Germany is a furnace which will have a power input of 3000 kva., and will handle 25 tons of metal.

The electric furnace will melt all the products which have been made in crucibles. In fact, some toolsteel analyses (such as Taylor's tungsten high speed steel) are melted more easily. The only limitations seem to be the transformer capacity and the purity of the ferro-alloys available. It is possible to hold the carbon less than 0.10%, with phosphorus and sulphur both less than 0.01%, which is purer than the usual alloying material available for completing the heat.

The cost is at least 30% higher than basic openhearth steel. Nevertheless, many enthusiasts predict electric steel will ultimately be so near the cost of openhearth that its superior quality will cause it to supplant the latter.

As it is in **1940**

WALTER M. (BILL) FARNSWORTH is superintendent of Republic's Canton Steel Division at Canton, Ohio. He has a new Heroult 60-ton furnace, installed to produce aircraft alloy steels, stainless, and other highly alloyed products. It is the second unit in a new electric furnace plant. To provide the working space, a modern well-constructed openhearth was torn out. The electric furnace has abolished the crucible, but has a major job ahead if it must now abolish the openhearth. For the near future, its field may be expected to dominate aircraft and stainless.

This furnace has a single 12,000-kva. three-phase transformer, but peaks up to 16,000 kva. cause no trouble. The highest voltage used is 260. Lower taps are 250, 230, 200, 150, and 135 volts — with 8000 kva. available on the low tap. Automatic control at any desired setting is so precise it is almost beyond comprehension. The furnace is extremely tight against air infiltration. The bottom is a monolithic lining of sintered periclase. The upper structure is conventional magnesite and silica brick. Electrodes are 18-in. graphite. Charging is entirely by machine.

It is making large amounts of 5% nickel and chromium-nickel-molybdenum aircraft steels. It also makes 16% chromium and 18-8 stainless — both with either 0.06% max. carbon or 0.12% max. The 18-8 products alloyed with titanium, molybdenum or columbium have been made very successfully. It operates entirely from cold stock. Time of a heat is about eight hours; three heats per day is the normal output. The monthly output will probably exceed 4700 tons, all of which is very fussy steel for specific applications.

The accessory equipment includes a carbometer for carbon tests during the working of a heat. Slag studies parallel the steel studies, to control inclusions better — a problem accentuated by modern-day Magnaflux testing of vital steel parts.

The first World War gave the electric furnace a push into production. Stainless steel later amplified the field for action. The present drive for aircraft, chemical, oil refinery and food processing equipment, bids fair to crowd the electric furnace into such volume of production that the basic openhearth may retire from the field of special steels as time goes on.

ALLOY STEELS

By Ernest E. Thum, Editor, Metal Progress

As it was in **1915**

INTERRUPTION of imports from Germany has thrown a sudden demand on American producers of fine steels, and new producers are finding trouble with surface seams and deep pipes in the thoroughly killed steel. While statistics are lacking, most of the production is from small open-hearth furnaces, although there is a very large electric furnace in operation at South Chicago. A shortage of manganese was apparent before the end of 1914; some concern is now felt over supplies of chromium and especially tungsten. Some automobile makers are substituting a good grade of carbon steel, properly heat treated, for some of the scarce alloy steels.

Cast chromium steel, tough, hard and wear resistant, has been made in America for at least 50 years, but its manufacture still remains a guarded secret. Civil engineers think of the 3½% nickel steel (not heat treated) as the high strength structural material. Much steel containing about 1% silicon was put into the hull of the Mauretania, and it is reported from England that a similar steel is used for its durability on curved railroad tracks. Hadfield's high manganese steel would be the American choice for such railroad service, as well as for parts to resist battering wear. Tough steels containing vanadium are favored by railroad engineers for heavy steam engine axles and connecting rods.

Much nickel and nickel-chromium steel is being used by the Navy for armor, guns and projectiles, but the compositions and heat treatments are state secrets. This secrecy in the art is a handicap to mechanical engineers who desire better machine parts; if they knew more about alloy steel and its treatment, the tonnage would increase rapidly. Most alloy steels are marketed under a trade name, and a similar steel from another firm is usually enough different to require a new treatment. A valuable move toward standardization has been taken by the Society of Automobile Engineers; it has established a list of acceptable and commercial compositions in nickel steels, nickel-chromium, chromium, chromium-vanadium and silico-manganese types.

It is claimed that a fractional percentage of copper greatly increases the corrosion resistance of ordinary steels; the American Society for Testing Materials is planning to expose samples in the open at various localities to determine the facts.

As it is in **1940**

TONNAGE of alloy steels (and carbon steels of alloy quality) is constantly growing. Statistics are faulty, for no precise definitions exist, so the figure of 1,475,000 tons of alloy steel in 1938 (5.2% of the total in America) is probably low.

An outstanding characteristic of the situation is its great complexity. With at least 11 common alloying elements other than carbon, the varieties of possible steels become almost infinite. Alloy steels for special purposes have been marketed in bewildering number and a recent handbook lists 256 separate specifications used by the major automobile companies alone. Information on the manufacture, properties and heat treatments has accumulated in thousands of separate publications. Fortunately the literature is being summarized by Alloys of Iron Research under SISCO's leadership, and a systematic theory of the functions of alloying elements has been formulated by BAIN. These will change impending chaos into understanding, and be the sure guide for future developments.

It long ago became apparent that many different alloy steels could be made to serve equally well in a given service — for a bevel gear, for instance. In mass production this is forcing the choice to the cheapest oil hardening steel that will give the desired properties. Concurrently the grain size has been brought under control, by proper refining in the openhearth and judicious use of aluminum, and this lends toughness, hardenability, machinability.

At present writing much attention is given also to steels of "aircraft quality", imposing a multiplicity of inspections such as for normality, sub-surface soundness, inclusion count, and homogeneity.

Balancing one trend to higher and complex alloys for special services in the chemical, petroleum and electrical industries come a multitude of "strong structural steels" having uniformly high yield strengths as rolled, easy fabrication and ready weldability (sluggish hardenability). Every important steel producer has one or more of these, designed for light weight railroad cars, or for machinery where inertia effects are important. Manganese, silicon, phosphorus and copper, the cheap alloying elements, are used in them as far as possible before turning to molybdenum, chromium and nickel.

TOOLSTEEL

By James P. Gill, Vanadium-Alloys Steel Co.

As it was in **1915**

METALLURGICAL and scientific control in the manufacture of toolsteel is still in its infancy; thus the making of toolsteel is yet definitely an art. Crucible melting furnaces are still in general use although the electric furnace had been introduced in 1908, and is being used much in the manner of a large crucible. Casting practice varies greatly in different mills and piped and "spongy" steel is a common problem.

Heating furnaces are of many types, using coal, oil and gas as fuel. Very few of the furnaces have temperature control. The atmosphere in the furnace frequently decarburizes the surface deeply, and a coarse grain resulting from overheating is common. Improved furnace equipment should give us a much more uniform anneal. Surface inspection is generally done with the aid of a file. Much toolsteel is graded by expert examination of a fractured bar-end.

In this year of 1915 there are a large number of toolsteel compositions available; nevertheless, about 10 distinct types probably represent 95% of the total production. These are the straight carbon, carbon vanadium, chrome-vanadium, tungsten fast finishing, manganese oil hardening, chromium hot work die steel, tungsten hot work die steel, two types of tungsten high speed steel and a tungsten high speed steel with about 5.00% cobalt. With the exception of die blocks for the drop forging industry no toolsteel contains sizable amounts of any one of the two common alloying elements silicon and nickel. Molybdenum is a semi-rare metal that seems to have possibilities.

Similar types of toolsteels vary greatly in physical properties, not only as made by different mills but even when made by the same mill. Very little information seems to be available regarding the characteristics and behavior of the different types of toolsteels and, consequently, the application of the proper type to any job is largely a matter of "Yankee guess".

As it is in **1940**

METALLURGICAL control in the manufacture of tool and fine steels is universal; thus, the manufacture of toolsteel is more of a science and less of an art. The electric furnace has almost wholly replaced the crucible method of melting, and has been greatly improved. Advantage has been taken of its flexibility so that toolsteels electrically melted are, in general, superior to those that were melted in the crucible. Casting practice, including mold design, has been intently studied and difficulty with pipe and sponginess in toolsteel bars has been largely overcome.

Heating furnaces have been greatly improved. Pyrometric control is general. Refractories, burners and furnace designs have been so improved that uniform heating is semi-automatic. All this has resulted in bars of a uniform structure and grain size, a minimum of decarburization, a good surface and closer size tolerance. Surface inspection by the use of a magnetic powder is common.

Carbon and carbon vanadium steels are now being produced that will harden in any one of a number of case depths, and yet have a fine grain. Much has been learned in controlling the distribution of the carbides in highly alloyed steels.

A much greater variety of chemical compositions is available. Generous use has been made of the element molybdenum in both the low alloy and the high alloy types. Advantage has also been taken of the known effects of nickel and silicon. High carbon high chromium, silico-manganese, and chrome-nickel-molybdenum steels are now available in a number of compositions. Choice may be had of a wide range of steels that will harden in oil and other types that will harden on cooling in still air. Use of molybdenum as a substitute for tungsten in high speed steels has increased the number of high speed steel types to 15 or more distinct compositions.

Considerably more is expected today of tool materials than some 25 years ago. They not only must give a much longer life but they also must withstand higher shocks, pressures and temperatures. Many types of toolsteels have been intently studied so that the selection of steel for most applications can be made with assurance.

STAINLESS STEELS

By Frederick M. Becket, Union Carbide & Carbon Corp.

As it was in **1915**

EXPERIMENTAL WORK has been conducted during many years at various laboratories on the alloys of iron and chromium, and the high nickel-chromium alloys have been commercialized as electrical resistance elements withstanding oxidation at high temperatures. Our own work on the chromium-iron and chromium-manganese series has shown that at least 20% chromium is necessary to effect an adequate resistance to oxidation at temperatures above 1800° F. and an effective resistance to acid attack; however, in neither direction has our experimentation gone beyond exposure tests in several plants. A good market should be eventually developed.

Most metallurgists will be pleasantly surprised by the recent achievement in England of HARRY BREARLEY — the development and commercialization of a cutlery alloy having noble properties and termed "stainless steel". It is understood that commercial production of this steel will be undertaken in this country within a few months. The stainlessness seems to result from the combined effect of alloying and heat treatment. The production of such steel on an industrial scale in itself is a great accomplishment; not only has it been necessary to develop proper casting practice, but in addition to master the very difficult technique of forging. The cutlery so produced is said to retain its finish, so that despite the high cost a ready market is expected for this steel, which will be treasured by the housewife and artisan for its stainlessness.

The relatively small amount of chromium used in this steel and particularly the function of the special heat treatment are puzzling. Can it be that the chromium imparts nobility only when present in beta iron? And yet to confer resistance to oxidation the chromium alloys do not require heat treatment. No doubt further work will clarify these phenomena, and it may even furnish the key to ennobling the ferrous alloys — a dream of the ages!

As it is in **1940**

DEVELOPMENTS in stainless steel since 1915 have been truly remarkable. In 1939 about 150,000 tons were produced in the United States. The austenitic 18% chromium, 8% nickel type represented the largest portion; another large part comprised the low carbon, 13 to 18% chromium type; an important tonnage included heat resisting alloys containing 24% or more of chromium. The high carbon cutlery steels constituted a small proportion. Evidently most attention has been devoted to the austenitic steels. Today the early difficulties with intergranular corrosion have been eliminated by the addition of titanium or columbium. Corrosion resistance has been improved with respect to non-oxidizing media by including molybdenum in the analysis. All these materials have found wide application in the process industries wherein (as in other uses) the development of adequate welding techniques has been of prime importance.

The steels have also found wide use in railroad trains, tank cars and aircraft. These uses rely on austenitic stainless steels, cold rolled to high tensile strengths. Only the recent years have brought full success to the cladding of carbon steel with a truly bonded layer of the corrosion resistant variety.

Of the low carbon, plain chromium steels, the type containing 25 to 30% of the element has found increasing use in structures resistant to high temperatures, especially since the addition of nitrogen has been used to inhibit grain growth in the rolled forms and to restrict grain size in castings. Such castings usually have even higher contents of chromium, and often have nickel as high as 20%. Low carbon steels containing 14 to 16% chromium, sometimes with nickel in small amounts, find growing use in turbine blades, airplane parts, and in other objects requiring the properties that heat treatment confers. All these and many other developments engender thoughts of the future. Perhaps we are not too far from the absolute control of corrosion in ferrous materials — a dream of the ages!

FERROUS CASTINGS

By H. A. Schwartz, National Malleable & Steel Casting Co.

As it was in **1915**

In 1914, with the outbreak of the War in Europe, the foundry industry had encountered something of a depression. Some far sighted (or super-nervous) foundrymen then contemplated the possibility of social dislocations consequent on unemployment, but in this year of 1915 the demands of the Allies have increased production considerably.

Nobody knows the cast iron tonnage produced. The tonnage of malleable castings is probably about 750,000, and the steel tonnage is a little under 900,000. There are about 4500 gray iron foundries, 196 malleable foundries and 300 steel foundries in the country.

Gray cast iron is lowest on the scale of engineering properties. The American Society for Testing Materials has four specifications; the only one referring to tensile strength specifies values from 18,000 to 24,000 psi. Current and newly written malleable specifications call for tensile strength of 38,000 psi. and elongation of 5%; cross bending tests, of doubtful meaning, are also included. Steel castings are covered by three grades running from 60,000 to 80,000 psi. in tensile strength, 27,000 to 36,000 psi. in yield point, 22% to 15% in elongation and 30% to 20% in reduction of area. Alloy steel castings have as yet received no particular attention from specification writers, though so-called "pearlitic" manganese steels have been in use, especially after quenching and tempering.

Steel castings are extensively absorbed into railway car construction, where they have replaced malleable castings — which in turn are finding a larger market in automobiles.

Much hand molding from gated or plate patterns is still done even in shops engaged in repetition work. Molding machines of the "stripper plate" type are being installed for fairly large jobs. Air operated vibrators have come into use. Jolt ramming for large work or air squeezing is a rather new development. Sand is usually prepared by hand on the molder's floor, although a central preparation room is installed in one truly mechanized foundry.

As it is in **1940**

Again we are in a period immediately following the beginning of a European war. It also initiated an increase in foundry outputs — not, however, so closely connected with a preceding minimum. We are acutely conscious of an unemployment problem.

The gray iron industry still has no data on its total production but the number of foundries is about 3050. Some estimates give the production in 1936 as about 11,500,000 gross tons.

Malleable castings, in an amount probably definitely in excess of 408,000 tons per annum, are now produced by a total of about 138 foundries. Not far from one-third of this tonnage is the product of two corporations.

Production of steel castings in 1938 was 343,000 tons (certainly largely exceeded in 1939) emanating from about 299 foundries.

For gray iron the A.S.T.M. specifications now provide for tensile strengths from 20,000 to 60,000 psi. and the older deflection tests are passing out of existence. There are now three malleable specifications providing for tensile strengths of 40,000, 50,000, and 53,000 psi., yield strengths of 30,000, 32,500 and 35,000 psi., and elongations of 5%, 10% and 18% respectively. Alloy steel castings are prominently recognized in the American Society for Testing Materials' specifications running from 75,000 to 150,000 psi. minimum in tensile strength, 40,000 to 125,000 psi. in yield strength, 24% to 10% in elongation and 35% to 25% in reduction of area. Carbon steels are specified from 60,000 to 75,000 psi. minimum tensile, 30,000 to 38,000 psi. minimum yield, 22% to 26% elongation and 30% to 38% reduction of area.

Alloy steels have become very common and steel castings have spread into all types of engineering construction, their use in petroleum refineries being perhaps noteworthy. Steel castings, which 25 years ago were predominantly made in the openhearth with some bessemer steel. *(Continued on page 356)*

ANNEALING OF SHEET

By E. G. deCoriolis, Surface Combustion Corp.

As it was in **1915**

"SAY, BILL!" said the Sheet Mill Superintendent, addressing the Head Annealer, "the Boss says that the last shipment of sheets we sent to Rolls-Pierce Motor Co. has been rejected. They got the crazy idea of putting their headlights into the front fenders of their new 1915 model. And what do you think? They wanted to press both the fender and headlight casing from the same sheet! Ain't that crazy? The Boss says unless we can anneal a sheet that will satisfy Rolls-Pierce we are likely to lose their whole account. Do you think you can do it?"

"Well, John! I ain't so sure I can, but I'll try. That heat of steel I got for that last shipment acted kind of funny. I annealed one box load same as I always do and when I bent some over to see how soft it was, it cracked after the second time. Then I tried to anneal a second load (that's the one we shipped to Rolls-Pierce). I gave her a mite more heat, kind of a cherry red. I told the night heater to hold her that way for about six hours. But he had trouble holding his fire because the coal clinkered pretty bad and pulled his fire down. You tell the Boss to have Jim at the openhearth give me an extra good heat of steel. And be sure to tell Hank to heat them sheet bars in his No. 2 furnace. She works the best and gives a nice soft heat. Also tell him to watch how he dips his sheet pack in charcoal and keep an eye on his fire so his heat don't get too rash on him. I'll try one box in my No. 4 annealer and watch it myself careful. I got some good coal I've saved up and it will give me a good hot fire. Then if the wind don't shift to the east and kill my draft I think we'll give them fellows the kind of sheet they are looking for. You leave it to old Bill."

A month later Bill's specially nursed heat of sheets was received by Rolls-Pierce. After three weeks of arduous work, involving considerable grinding and reshaping of dies, they succeeded in forming their special fender for the new model. All went well until another shipment of steel was received. Old Bill's coal must have clinkered again! The whole shipment had to be rejected.

As it is in **1940**

A COMPLAINT was received by the Strip Mill Superintendent from the Detroit Sales Office that two coils from the last carload of strip had caused some trouble, involving 3% rejects. He called up the laboratory and received a report that the heat from which these coils had been rolled was fully up to specifications, both physical and chemical. He then called for the annealing department records. The sheets had been annealed just the week before. The temperature charts were produced showing that all coils in this particular carload had been annealed simultaneously in a single two-row annealing cover, and all time-temperature curves agreed closely with the established practice.

Next he consulted the records of the slab-heating furnaces. Everything had proceeded normally during the time the slabs were being heated. There had been no hold-ups. The finishing temperature charts showed uniform control. It could not be the hot strip mill, according to the foreman, for rolls had been recently inspected, everything was in order — all except for one small delay. The gager on the finishing bed had been a little slow in checking the gage of one strip, so that the strip following had been held up slightly and had finished a little colder than usual. The Superintendent checked up "one" in his notebook.

To the pickling department he went. Once more records were pored over. All seemed to be in perfect order. Fresh additions of acid had been made according to schedule. Temperatures had been kept up to normal. One notation caught his eye: Some trouble had occurred one night with the recoiler. It had taken some time to fix it and during that period a strip had remained in the pickle tanks. The foreman had examined this coil which apparently showed no damage. But the Superintendent made another check in his notebook, satisfied that he had located the cause of the complaint.

The best of modern mills do have breakdowns and hold-ups. But they are getting fewer and further apart. Taken on the whole, the annealing department is now well under control.

STEEL TREATING

By Harry W. McQuaid, Republic Steel Corp.

As it was in **1915**

AN EFFORT is being made, by a group of heat treat foremen in the Detroit District, to pool their information on the problems of steel treatment and perhaps to start some researches on questionable points. Variations in both the alloy and carbon steels are very great — not only in the number of grades and types available, but also in lack of uniformity of response in a single shipment. Heat treatments are likely to become very involved, and the necessity for more information is apparent. As a matter of fact, conditions in the shops are not too good to attract the best type of workmen. Smoky, poorly lighted and poorly ventilated heat treating departments are the rule, and a 12-hr. day, 7-day week not unusual in busy seasons.

Notable improvements in temperature measurement have recently been made in the potentiometer system which is not nearly as sensitive as the older galvanometers to variations in thermocouples and to stray currents. Automatic fuel control, based on temperature measurements, has been introduced in a few plants and is attracting much attention.

Carburization (case hardening) is done in patented compounds. The work is usually cooled in the box, and — especially if alloy steel — double treated to give good fractures. Gas carburizing, using no solid carbon, is reported to be quite successful abroad, the theory having been described in a recent book by the Italian metallurgist, FEDERICO GIOLITTI. Some attempts over here have been made, using a rotary muffle for containing the work, but these high alloy muffles are expensive and do not last very long.

From the standpoint of furnaces at his disposal the heat treater has little complaint. Carefully engineered, underfired furnaces for hardening heats are available and will perform very satisfactorily — especially when using gas for fuel. Rotary retorts for continuous work, hopper fed and automatically discharging, are giving good results in roller bearing plants. Furnaces heated with electrical resistors are being offered. Pyrometers are useful in showing the operator whether his furnace is hot or cool, thus aiding the educated eye. Temperature of high speed steel, to be quenched very much higher, is determined almost entirely by "scale blister".

As it is in **1940**

HEAT TREATERS now have a much simpler task than the pre-War practitioners. Not only have control instruments been perfected, but it is a much simpler problem to obtain uniform results from today's steels, made to controlled hardenability and grain size specification. Working conditions are vastly improved wherever heat treating is done as part of the factory line-up or in a department of importance. Specialization of furnaces has been another result of mass production, although most of the general types in common use today were well developed 25 years ago. However the necessary materials which now make continuous furnaces so satisfactory were lacking. Without our first-class heat resisting alloys it is doubtful if we would be doing more "continuous" heat treating now than in pre-War days.

Carburizing boxes are much lighter and have long life. Carburizing compounds are quite well standardized, and their handling and proportioning more scientifically controlled. Use of fine-grained carburizing steels made possible the direct quench from the box (and higher carburizing temperatures) with the many savings in such practices.

A new family of alloy steels involves a type of heat treatment by normalizing and drawing, and is of great importance in some industries. Annealing and normalizing, to improve machinability, have grown to be a common practice in the last 15 years. Draw furnaces are greatly improved in design, principally by the use of circulating atmospheres, heated in separate chambers and driven across the work by fans; they result in closer hardness tolerances on steels of controlled hardenability.

The next 25 years will probably see even greater improvements in heat treating technique. Atmosphere control, high frequency electric furnaces, flame hardening, pressed powdered metals, heat treatment of castings, isothermal treatments both for annealing and hardening, will increase rapidly. Lower alloy steels made to give greatly improved hardenability and physical properties will require more closely controlled heat treatments if maximum machinability and performance is to be obtained. Changes will come at what seems to be a slow rate, but when looking back from 1965, they will appear to have been many in number and rapidly made.

HEAT TREATMENT OF
CAST STEELS & IRONS

By R. H. McCarroll, Metallurgical Department, Ford Motor Co.

As it was in **1915**

HAVING JUST ENTERED the automotive industry, we are surprised to find the changes that have occurred in the heat treatment of cast ferrous alloys since our university instruction in these subjects.

Some gray cast iron is being heat treated for better machinability or to remove strains. A considerable quantity of gray iron made with the addition of steel in the cupola is being used in such castings as cylinder blocks where better strength and wear resistance are needed. Alloy irons that may be heat treated are being produced experimentally.

The use of chills in the molds is also being further developed to produce hardened sections in castings where desired.

Malleable iron has become a much more uniform and reliable material, its average physical properties having been improved by better control of the heating and cooling cycle. There is even some work in progress, using different heating cycles more closely controlled, with the hope of producing a still stronger malleable iron in less time than the now fairly general practice of seven days.

Low carbon steel castings are replacing some malleable iron, particularly for large work, after having been given an improved and more uniform anneal.

Liquid baths, other than cyanide, are being developed. They should reduce the cost of cleaning work after heat treating, and therefore increase the proportion of heat treated parts used.

Pyrometric control has been improved so that even the "old-timers" are willing to place more reliance upon it.

The progress made in the last 10 years is, we of 1915 think, very remarkable.

As it is in **1940**

TWENTY-FIVE years from now, we suppose, anyone reading what we write today, will feel as we do about what we wrote in 1915. New compositions of ferrous alloys have helped to change the whole picture. New methods and equipment have opened a new world of possibilities. We have new ideas on what can or should be heat treated.

Alloyed gray irons are being heat treated in large quantities. On the other hand, many automotive parts of intermediate composition, such as push rods and camshafts, have had their heat treatment eliminated; this was done by close control of the composition, pouring temperature and cooling rate.

Valve seats and cylinder bore liners, many of them cast and heat treated, have changed the requirements for automobile cylinder blocks.

The use of chills for selective hardening has almost been eliminated.

Malleable iron more than 25% stronger than was available in 1915 is being heat treated in 15 hr. or less — thus saving more than six days in the process! Beyond this we have a wide variety of "pearlitic" malleables and heat treated malleables.

Many articles, particularly for the automotive industry, which in 1915 it would have been considered ridiculous to cast and heat treat, are now being manufactured in that manner. These include crankshafts, pistons, valves, transmission gears, rear axle gears and rear axle housings. Often these are single castings that replace two or more pieces, formerly fabricated separately, and riveted or welded together afterwards.

Gas atmosphere furnaces for both light and deep case carburizing are now heat treating steel castings. Clean annealing, continuous furnaces have reduced the cost of castings. Selective hardening by gas heating, induction heating and resistance heating has still further extended the field.

These new compositions, new methods, and new equipment for heat treating have made possible new engineering designs and new cast products.

CARBURIZING

By J. F. Wyzalek, Hyatt Bearings Division, General Motors Corp.

As it was in **1915**

CARBURIZING is one of the most ancient practices in the metallurgy of iron, and one of the first to receive scientific attention. Nevertheless, carburizing compounds have only recently escaped from the stage of secret formulas and entered a basis where purchases may be made on a competitive basis. There seems to be a trend toward compounds based on coke charcoal, using sodium, barium, and calcium carbonates as "energizers". Such material is not only considerably lower in cost than the privately mixed material using raw bone, boneblack, charred leather, and other organic substances, but at the same time has a considerably increased volume with a lower shrinkage, heat conductivity and better life.

A recent innovation is the use of screens and mixers for cleaning and proportioning of carburizing compound and its ingredients, effecting thereby a more uniform mixture free from ash, dust, and other contaminations.

Localized carburizing has advanced from the stage where the portion desired soft was buried in sand, to a more scientific method of control, using copper plating or stop-off washers to prevent contact with carburizing gases.

Carburizing in muffles containing carbonaceous gases rather than solid compounds is a recent proposal and the process is in semi-commercial production both here and abroad. Several gases have been proposed for this use; results are apparently quite various and are frequently affected by heavy carbon deposits.

In a number of shops oil-fired furnaces are replacing antiquated coal-fired equipment and accomplishing much better results through an improved temperature uniformity. Lastly, better temperature control is now available by using pyrometers hooked up to switchboard arrangements with signal lights. Technical control of carburizing has also been greatly advanced by using the microscope, toward accurate content of carbon at the surface with desired carbon gradient.

Scientific understanding of the process will undoubtedly be greatly advanced by the English translation of Dr. GIOLITTI's work on "The Cementation of Iron and Steel".

As it is in **1940**

NUMEROUS satisfactory compounds are now available, commercially, under proprietary names, of which the most widely used are based on hardwood charcoal and petroleum coke. With these an admixture of one third new is desirable for each use of old material. A smaller proportion of new is sufficient for the pellet types and the finer ones based on boneblack. In any event, careful purchasers now specify composition, nature of energizers, limits of undesirable sulphur and moisture, particle size, specific volume and shrinkage per run.

Superior heat resisting alloys have been perfected for carburizing boxes (and muffles for gas carburizers). Shape and size of the box is as important as long life, as it is a sheer waste to heat up large masses of container and surplus carburizing compound.

Furnace designs have been continually improved. Batch types of furnace still handle most of the work other than the mass production of articles (sometimes the latter are made in such quantities that special furnaces are constructed for them). Continuous furnaces of the counterflow type are quite economical for uniform production of medium-sized parts. Rotary batch type furnaces are probably best for small parts. Gas has become the most common fuel.

Direct quenching from the carburizing heat is common practice with steels so controlled that recrystallization (excessive grain growth) does not occur until the part is hotter than the usual carburizing temperature, say 1650 to 1750° F. Practically all alloy steels of carburizing grades are now procurable from the steel maker in the "fine grain type".

Carburizing in gas atmospheres has been perfected during the past ten years. Speed of the operation is increased by saving the time necessary to bring the container and carburizer to heat. Satisfactory gases are obtained by mixing natural gas or volatile hydrocarbon with a flue gas, or by using a partially burned fuel gas (natural gas or city gas). Success involves good temperature uniformity and constant circulation of gases over the work.

HEAT TREATMENT OF
NON-FERROUS ALLOYS

By D. K. Crampton, Director of Research, Chase Brass & Copper Co.

As it was in **1915**

During recent years there have been few developments in the art of heat treating non-ferrous metals. And it must be admitted that this is still an art, the uniformity and quality of the product being largely a matter of the skill of the experienced annealers. In this it is akin to the annealing of steel.

Wood-fired furnaces still lead the field for finished annealing, due to the better surface of the metal heated with wood flame as compared with that resulting from the use of coal, oil or gas. However, good wood at low cost is becoming increasingly scarce and there is a trend toward other fuels.

Coal is used for intermediate anneals where temperatures are higher and less accurately controlled and where slightly blemished surfaces are less important or can be corrected later. Many oil-fired furnaces are being introduced in competition with coal, but neither of these is satisfactory for finished work.

Some gas-fired furnaces have been introduced, and the indications are that the use of this fuel will increase. While not as economical as oil or coal, gas does lend itself to easy control and the quality of the surface obtained approaches that obtained when wood is used.

More thought is being given to design of furnaces — particularly with regard to questions of relative dimensions of fire box and annealing chamber, height of arch, and placement of baffles — to effect more uniform heating and perhaps some fuel economy. However the furnaces have not changed greatly in basic design.

The use of pyrometers particularly on furnaces for finished work is increasing. In some instances the pyrometers only indicate the temperature, the actual control of fuel still being manual, but a trend toward full-automatic control is noticeable, particularly on oil-fired and gas-fired furnaces.

As it is in **1940**

Perhaps the best general statement as to developments in heat treating of non-ferrous alloys is that this has changed from an art to a science. Now relatively little depends upon the skill and experience of furnace operators. Questions of economy, control and quality are largely inherent characteristics of furnace design as a result of careful engineering.

The older batch-type furnaces are used less frequently. New furnaces are more often than not of the conveyor type. Also the handling of metal is markedly improved both to and from the furnaces and through the furnace.

Wood and coal-fired furnaces are fast disappearing, oil, gas and electricity being the principal energy sources. In general (although not always) a controlled atmosphere is required for much finished work and even some intermediate annealing. Such atmospheres are obtained in several ways. With gas, controlled combustion in direct fired furnaces is quite successful for many types of work. In other instances full-muffle type furnaces are used; in them less attention need be given to the composition of products of combustion for the atmosphere is prepared in a forming unit outside the furnace and led in under slight pressure.

In addition to the questions of uniformity of temper and atmosphere, the introduction of alloys of the age-hardening type requiring rapid cooling from medium or high temperatures has had a considerable effect on furnace design. Many furnaces are now available which heat material accurately to a predetermined temperature in a controlled atmosphere and then either quench or dry cool in the protective atmosphere so as to give both metallurgical properties and desired finish. In some instances such protected cooling is required to prevent oxidation on coming into the air; many furnaces are producing copper and certain alloys annealed thoroughly soft, as bright as drawn work, entirely free from any surface discoloration, absolutely dry, and cool enough to handle with bare hands.

OXY-ACETYLENE INDUSTRY

By John J. Crowe, Air Reduction Sales Co.

As it was in **1915**

THE OXY-ACETYLENE INDUSTRY is celebrating the tenth anniversary of the introduction into this country of the first welding and cutting torches. While most of the welding of iron, steel, and cast iron is being done in the back of the shop and for the purpose of covering up mistakes, there is sufficient work of the repair and salvage type to attract the attention of engineers to welding as an aid in production.

Filler materials are passing out of the "fence-wire period", when almost any composition was used as a welding rod. The more progressive welders are insisting on quality and are experimenting with such steel alloys as are available in the form of wire or sheared strips. At the rate of growth it is probable that a sufficient volume of demand will shortly arise which will warrant the production, in a steel mill, of special wire and rods for this purpose.

Aluminum ware, mostly of the kitchen variety, is being successfully repaired and fabricated with the welding torch. It is a sign of progress that aluminum welding is not confined to this class of work, and at least one manufacturer is using the oxy-acetylene welding torch for the fabrication of large tanks.

Welds in both ferrous and non-ferrous metals are generally sound, and when properly reinforced have the required strength, or out-pull the parent metal. Some engineers are disturbed by the lack in ductility — if judged by that of the parent metal.

The necessity for fluxes as an aid in non-ferrous welding is fully appreciated and a number of excellent fluxes are available.

Steel foundries have discovered that the cutting torch is a useful tool for the removal of risers. It is light, weighing less than two pounds, and is easily moved to the casting on the foundry floor. There is no necessity for moving the heavy casting to the machine shop for cutting off the risers by expensive machine tools. The limit of thickness that may be readily cut with the torches and gases available is of the order of 6 or 8 in., although a small amount of heavier cutting is being done. Much cutting is also being done for the purpose of demolition.

Low purity oxygen prepared by chemical means is being rapidly replaced by oxygen of higher purity prepared by the electrolytic process, and some headway has already been made in the production of oxygen by the liquid air process.

As it is in **1940**

THE OXY-ACETYLENE TORCH has now seen many improvements, and means for mechanically guiding and controlling the motion of the torch are now available. Such machines are capable of making cuts of such high smoothness and accuracy that for many purposes no further machining is required. In addition to improving the quality of the cut these improvements have resulted in more economical cutting.

Instead of looking on the cutting torch as a tool mainly used for demolition, it is now recognized as a tool of great value for the preparation of rolled plate and sections for fabrication, and is being extensively used for that purpose in many forge shops, structural shops, and shipyards. Modifications and improvements have made it available for flame machining, and in this connection it is being extensively used for the preparation of plate edges for welding and for removing defects from billets and blooms — the latter process being commonly known as scarfing or deseaming.

Improvements in the torches, gas pressure regulators, and auxiliary equipment — as well as in the technique of cutting — enable us to cut almost any maximum thickness of steel, even up to 60 in. or more.

The many improvements in the cutting torch have been paralleled by improvements in the welding torch and the technique of making welds. Welds are made which exceed in strength that of the parent metal and with a ductility comparable to that of rolled material. Other improvements have adapted the welding torch for flame hardening and flame softening. This use is rapidly expanding; heating tips have been made as wide as 18 in. and contain as many as 80 flames.

Another use recently developed for the oxy-acetylene flame has been that of cleaning or descaling in preparation for painting.

In the non-ferrous field improvements in welding rods have resulted in better flowing characteristics and an increase in bond strength.

All of the earlier methods of oxygen production, such as chemical means or by the electrolysis of water, have been almost entirely replaced by the liquid air process and the acceptable purity has been increased from 96% or 98% to 99.5%.

ARC WELDING

By Louis J. Larson, Consulting Welding Engineer

As it was in **1915**

THE USE of the arc welding process is increasing. Formerly used chiefly for filling holes in steel castings, it is now found very economical for repairing many parts of equipment, and in a few instances for fabricating new products.

Recently a generator designed for supplying welding current has been put on the market and several are now in use. This machine is of the constant potential type and supplies current simultaneously for several operators. The desired current values are obtained by adjusting resistance units in the separate welding circuits; thus the amperage in any arc welding circuit is independent of the number of arcs operating. It would appear to have some advantages over the necessity of having a generator for each workman.

In an effort to increase the stability of the arc and facilitate the welding operation, coatings of various kinds have been applied to the electrodes. Although these coatings do stabilize the arc more or less, they have not resulted in sufficient improvement in the weld metal to justify their cost, and most welding, in this country at least, is being done with bare electrodes. The most satisfactory wire is made from a pure low carbon iron from Sweden.

As compared to oxy-acetylene welding for iron and steel, the arc welding process is faster and cheaper. The metal deposited with the arc has a strength nearly equal that of mild steel, but its ductility and shock resistance are low, as measured by the usual laboratory tests.

Welded joints should be designed so the deposited metal acts in compression or shear and not in tension. When it is necessary to repair a break in a tension member, the butt-weld should be reinforced by suitable cover straps, fillet welded to the sides of the member.

By using oxy-acetylene welding for the more important joints and those subjected to tensile stress, and using arc welding in other joints, some manufacturers have been able to produce a satisfactory product at reduced costs — especially when one or only a few units are under order, which otherwise would involve high pattern costs or other preparatory expense.

As it is in **1940**

ARC WELDING has become *the* most important method of joining steels. By its use, it is possible to build structures cheaper or better, and many products now regularly fabricated by welding could be built in no other way. The process is widely used in the manufacture of pipe, hydraulic conduits, pressure vessels and all types of containers, machinery, structural steel-work, ships, buildings and practically every conceivable type of equipment.

An important factor contributing to the widespread use of welding is the improvement in welding machines. With the generators of today, the welder is able to make better welds and with less effort than with the old type of equipment. Many of the old variables and fluctuations are automatically taken care of by them. Both alternating and direct current machines of any desired capacity are now available.

The greatest factor in the adoption of arc welding is the development of covered electrodes. Electrodes have been developed for welding all the usual types of mild steel, most of the high strength and low alloy steels, and many of the stainless and high alloy steels. The mechanical properties of the metal deposited with the various types of electrodes are equivalent to those of the corresponding base metal.

With the modern type of welding the designer need have no fear of a joint subject to tension. The welded structure acts as a one-piece unit. For resisting repeated loads, stress concentrations due to abrupt changes of section must be given the same consideration in welded as in other types of structures. Heat treatment and stress relief are matters requiring expert attention.

Many of the chemical and manufacturing processes of today would not be feasible without welded equipment, and the cost of numerous products in every-day use has been materially reduced due to fabrication by arc welding.

RESISTANCE WELDING

By J. W. Meadowcroft, Edward G. Budd Manufacturing Co.

As it was in **1915**

UP TO THIS TIME the application of resistance welding (butt, spot and seam) has developed in the hands of shop men, and the interest appears to be in speed of production. The process appears to be so simple that the users of machines sometimes fall into the error of thinking they know all there is to know about the subject. Thus the development has been largely the result of mechanical ingenuity to the end of production speed. Not only is this ingenuity of a remarkable order but the results are on the whole surprisingly good from the standpoint of the objective. Unfortunately available methods of test are very meager and unsatisfactory; the same may be said of the means for control of the major welding factors.

More attention must be given to quality, as many failures have occurred in spot welded articles. The correction is naturally more welds, in some cases supplemented by rivets.

A mere enumeration of the devices and methods developed so far is far beyond the scope of this column, but a few significant ones may be mentioned:

"Flash" welding is rapidly replacing the original butt welding process, and has already increased the size of weldable sections by many times.

Butt-seam welding for the manufacture of thin-wall tubing has already been in use for over ten years. The field is very restricted, and the future will probably see developments for broader applications.

Lap-seam welding with the aid of roller electrodes has been proposed many years ago, but its development except for very thin stock has been practically blocked by lack of understanding of some of the phenomena involved.

In the case of spot welding and projection welding enormous strides have been made in the mechanical evolution of the art.

For thin gage material "poke welding" has played a large part in the manufacture of the first all-steel automobile bodies. It would seem that the substitution of a steel structure as an automobile body has very definite advantages over the use of steel sheathing around a wooden frame. The future will see more of them in use.

As it is in **1940**

THE RAPID STRIDES in the art of resistance welding are due in part to increasing demands for quality, in part to new apparatus available for control, and in part to a rapidly growing and more thorough understanding of the phenomena involved. The result is a rapid accumulation of accurate knowledge of the relation of the quality of a weld to the current, time, pressure, gage and kind of material. We have developed vastly superior timing devices, mechanical or electronic or both. In some critical cases recorders are used which record the heating power of the current for every weld.

Much research work is in progress on the distribution of heat in the weld zone, with particular relation to the electrical and thermal resistivity of metal and the contact resistance as related to the pressure and temperature. Residual stresses, more or less damaging, result from thermal gradients.

Where very heavy currents are necessary for heavy gages the current may be interrupted one or more times to cool the electrode. In seam welding a radical change is taking place which involves longer interruptions of current between shots.

Percussion welding has been applied to spot welding by discharging a condenser through the primary circuit of a welding transformer, also by breaking a direct current in the primary of the welding transformer—both definitely superior for very rapid heating of thin material or material of high conductivity.

Butt-seam welding for manufacturing steel tubing or pipe constitutes a new industry of considerable magnitude.

There have been more intelligent applications of resistance welding to critical structures in the past ten years than throughout its previous history. The speed with which the scientific method has been applied is due in considerable part to the work of the Welding Research Committee of the American Welding Society.

POWDER METALLURGY

By Zay Jeffries, Incandescent Lamp Dept., General Electric Co.

As it was in **1915**

POWDER METALLURGY, as the art of making objects by heat treatment of compressed metallic powders, with or without the addition of non-metallic substance, has not yet reached the dignity of a special place in metallurgical art and science. Even so, the art is old. Skipping the question of whether or not some of the primitive iron objects were made by powder metallurgy, the WOLLASTON process for consolidating and working platinum powder had been known for nearly a century. Also, when oxy-hydrogen burners and refractory crucibles became available, long before 1915, platinum objects were made by melting and casting to such an extent that the WOLLASTON process became practically a lost art.

Nevertheless, powder metallurgy scored magnificently early in this century when the first tungsten lamp filaments were produced. For a few years, filaments sintered but not worked were used, but even the ductilization of tungsten resorted to powder metallurgy in the preparation of the ingot. By the time of writing (1915) the production of substantially pure wrought tungsten and molybdenum is in full swing in several parts of the world. Thorium dioxide had been added to the tungsten powder in an early stage of manufacture for retarding grain growth in the filaments during burning. It was then recognized that melting and casting could not compete with the powder method in the production of thoriated filaments, for no way was known to get the fine and uniform oxide distribution, or even to retain in the cast product substantial or definite amounts of the desirable non-metallic substance.

Wrought tantalum has been produced by powder metallurgy, but its commercial application has gained no headway. Several products have been made by powder metallurgy. Among these, tungsten and molybdenum X-ray anodes, tungsten X-ray cathodes, and wrought tungsten contacts for automobile ignition systems deserve especial mention.

As it is in **1940**

Millions of pounds and pieces of objects now come from the powder metal factories each year. The new shapes, sizes, compositions and uses are too numerous for specific mention.

There has been a marked expansion in the 1915 products. More than a billion tungsten incandescent lamp filaments and tens of millions of tungsten radio tube heater filaments are used each year. Tantalum products are used for many purposes.

Two of the largest automobile manufacturers have powder metallurgy "divisions" specializing in copper products like bearings, bushings and motor brushes. Various mixtures of copper and graphite or copper and non-metallic substances with other powdered metals are produced currently. "Elkonite" is made by pressing tungsten powder and filling the interstices with copper; it is used for welding electrodes for its high electric and heat conductivity and high hot compressive strength.

"Alnico" magnet material is new. Although it can be made by melting and casting, it cannot be subsequently shaped by mechanical work. By compounding the ingredients in powder form (iron, nickel, aluminum and cobalt) pieces of small size and intricate shape are easily made.

Of the newer products of powder metallurgy the cemented carbides are outstanding. These cannot be made by the conventional melting and casting methods. The principal powders are tungsten, tantalum and titanium carbides, and cobalt. The sintered products are the hardest and most wear-resistant metallic objects known and have the highest compressive strength. Their use as drawing dies has revolutionized this art; as cutting tools they are having a profound effect on machine tools and machining operations; they have solved some difficult problems in wear resistance.

Finally, the admixture of metallic powders and diamond fragments, simultaneously heated and pressed, has produced new and useful products for small grinding wheels, dressers and core bits.

FORGING

By Adam M. Steever, Columbia Tool Steel Co.

As it was in **1915**

THE YEAR'S WORK-LOAD clearly discloses the fact that the forging equipment of the country is barely adequate to furnish the normal needs, and entirely inadequate for the added sales which are appearing.

As the year ends, many new board hammers, forging hammers, and miscellaneous equipment are on order. The new hammers will replace equipment that is badly worn, slow and clumsy, and will also add new facilities to meet the new demands. The new work-load has shown the need for changes in the cross section of the cast iron frames of all forging machinery and it is hoped that the larger sized cast iron anvil blocks will prove more satisfactory and provide more effective work from the hammers, eliminate the necessity for frequent re-setting of the die blocks, and give greater accuracy to the finished forging. These changes should also reduce breakage of anvils, legs, base plates and other important parts, as well as increase the life of equipment by permitting the owner to rebuild the removable guides by re-machining them, and thus prolong the total life of the equipment.

The War in Europe has started many plants making munitions in this country. The railroads are finding it necessary to increase their equipment to maintain and build cars and rolling stock, and the automotive industry is extending the use of forgings. The railways have shown a further interest in steel railway cars; heavier under-carriages are required in the change-over from wooden equipment. The large automobile makers have an increasing interest in alloy steels, which add difficulties to the makers of drop forgings. Many new plants are interested in the possibilities of hot piercing for munition purposes.

With the completion of deliveries of new equipment on order, the industry should find itself in good shape to meet the demands upon it.

As it is in **1940**

AFTER an era of peace and alternating prosperity and depression, war is again in Europe. To date, the demand on the forging industry for munitions has not been substantial. Foreigners seem convinced that the American forging practice is superior to their own and have bought much of our forging equipment. Some American manufacturers have built plants abroad which will take care of some of this demand.

The severe requirements established in the past few years have taken the fullest advantage of cast steel frames and anvils of enormous size, with heat treated alloy steel for other important parts of forging machinery. Adjustable and replaceable guides and other wearing parts, larger columns, with increased anvil-bearing surfaces, and changes in valves have revolutionized the equipment.

In steam drop hammers, the *average* size of installations has increased to approximately 8,000 lb. (with largest units running to 50,000 lb. for manufacturing airplane engine parts and propellers, either of stainless steel or aluminum alloys).

Large mechanical presses are making various types of forgings. After a period of interest in and trial of equipment of extraordinary size without too satisfactory results, orders are now commonly being placed with a rating up to 22,000 lb.

A new type of stamping equipment — a cross between the operation of a press and a hammer — is successfully forging cold stainless steel and aluminum alloy shapes for airplane wings and bodies, exhaust manifolds, and similar parts. New alloys with poor drawing qualities require an impact blow to put them into final form and have caused a new interest in the forging industry. Manufacturers are showing a willingness to risk tremendous sums to diminish tolerances and increase the dimensional limitations of present forging equipment. The coining of forgings has progressed to a new high point in better finishes and accuracy.

Other concurrent improvements are in heating facilities and pyrometer control. As a result of these changes, it appears that the demand for forged parts will grow in the next few years whether we have war or peace. The industry is in an excellent position to assume its added responsibilities.

ROLLING MILLS

By John B. Tytus, Vice-President in Charge of Operations, American Rolling Mill Co.

As it was in **1915**

IN THE MANUFACTURE of sheet metal, no material changes in mechanical principles have been made since the invention of the original two-high mill, beyond a constant increase at various periods in size and weight of rolls, housing, couplings, etc. . . . . Sheet mills, jobbing mills and tin mills all have the same simple form. The top roll is driven simply by the friction caused when it is forced against the bottom roll by means of screws. . . . .

In the early days, all sheet, regardless of gage, was rolled single, that is, only one sheet from a bar. . . . . In the early nineties, two distinct methods of sheet rolling developed. . . . . The prevailing method was to keep the rolls cold and roll the packs loose by opening up the pack after each pass and throwing some satisfactory substance between the sheets. . . . .

It was discovered, however, possibly in tin mills, that by heating the pack to a certain temperature, and combining this with a certain amount of draft, or pressure, and a hot roll, the sheets composing the pack would set and roll together as a single sheet. After cooling they would be separated without any trouble. . . . . It has been found that, owing to the "spring" or "give" on the mill, it is impossible to secure the proper draft on a piece after it reaches a thickness of less than about 0.10 in. It has been found necessary to put enough sheets together to make the thickness of the entire pack 0.10 in. or more.

Many attempts have been made to hot roll sheets in a manner which would require less physical labor by using a continuous arrangement of rolls and passing sheets from one stand to another by conveyors. . . . . All such attempts have failed due to the sudden changes in the shapes of the rolls. It is still the opinion of some practical men that such improvements will be made. . . . .

As it is in **1940**

SIXTEEN companies in the United States and three foreign countries have installed the continuous method of rolling sheets since 1926. The capacity of these mills probably exceeds 13,000,000 tons per year. Sheets are rolled directly from slabs — first reduced to coils on hot strip mills, and further reduced to required thickness on cold strip mills.

The construction of the first continuous sheet mill by The American Rolling Mill Co. in Ashland, Ky., which started operations in 1923, was made possible by making allowances for all the following factors:

1. The prepared contour of the rolls.
2. The temperature of the rolls.
3. The composition and springiness of the rolls.
4. The spacing of the rolls.
5. The shape, composition and temperature of the piece.

The main objective was to determine and control all of these variables, and the mill was designed so that each piece moving through it would have a slightly convex cross section, and after each successive pass would have progressively less convexity. This was before the invention of the four-high mill.

With the four-high mill came other advancements. It was possible to maintain more control over the spring of the rolls. Heavier housings permitted greater rigidity. Roller bearings were developed which greatly reduced the power requirements, minimized the dangers of roll breakage caused by excessive stresses and heat in the roll necks, and permitted more precise control of the piece. It was this combination of subsequent developments which has made it possible to roll hot coils from slabs.

The continuous hot and cold strip process has made it possible to roll sheets commercially with a precision of gage, uniformity of quality, and perfection of surface which has opened up many new markets for sheet metal.

While many experiments have been made relating to the action of metal between two revolving rolls and in the reduction in thickness and consequent elongation of the piece, much still remains to be learned as to what happens to the various particles of metal. The acquisition of this knowledge will give impetus to further rolling progress.

WIRE DRAWING

By Kenneth B. Lewis, Consulting Engineer

As it was in **1915**

AN OUTSTANDING FACT in recent wire mill development is the firm establishment of the cast iron die. Die costs now run as low as 33¢ a ton, and a die hole will generally finish a 300-lb. bundle within commercial tolerance.

It is hard to refine wire machinery in the face of a general disinclination to pay over $300 per block for rod frames, but some discussion of cut gears is heard. We continue to hear rumors of continuous dry drawing in British mills, forced by union restrictions, but here no one takes any stock in the possibility of either union interference or continuous rod drawing. American mills report drawing speeds as high as 400 ft. per min.

Output per man-day has apparently reached its peak. It can be figured closely by dividing 25,000 lb. by the number of drafts plus one. This works out for two holes No. 10 gage 8300 lb., three holes No. 12 gage 6250 lb., and four holes No. 14 gage 5000 lb. This formula shows that the limiting factor is the tonnage a man can lift in a day, and this will change only when we breed a race of supermen.

It has been proven that it pays to bake rods at higher temperature and to provide definite ventilation in the ovens. If the flues are kept under a grid floor and if air is admitted beside them and vented through holes in the roof, baking can be cut from 24 hr. to 5 or 6 hr. Temperatures as high as 350° F. are safe, if the circulation is good.

In Europe, where the explosives industry is absorbing all the acid, pickling is being done with niter cake, a sulphuric material carrying nitrogen, and the wire is said to absorb less hydrogen than usual. This compares interestingly with American experiments using protein-bearing additions such as "red-dog flour", and leads to speculation as to whether these compounds, said to prevent action between bare metal and acid after the oxide is removed, will ever come into practical use in the wire mill.

As it is in **1940**

THE RECENT REVOLUTION in wire practice owes much to the tungsten carbide die, which has driven out all rivals except in finest sizes, where diamond dies are found. Die costs are of the order of 11¢ a ton, and the usual life of a hole is 100,000 to 200,000 lb. of steel wire drawn.

Wire machinery has now taken its place alongside the machine tool in degree of refinement. A motor and speed control for each draft is commonly installed, and prices on the continuous machines (which are now in almost universal use) range upwards of $2000 per block. Finishing speeds in the nail sizes run 1000 to 1500 ft. per min.

Output per man in three common gages runs: No. 10, 24,000 lb., No. 12, 21,000 lb., No. 14, 18,000 lb. It is limited by the agility of operators in butt-welding for non-stop operation, and the willingness of the user to accept large bundles. Both of these factors are subject to revision, so the above figures do not represent finality.

Among accessory items the flash baker typifies the modern trend. It flushes limed rods with a hurricane of air at 750° F., driving out moisture and hydrogen in two to six min., and, because of its shape and size, has moved into the cleaning line and become a part of the pickling layout.

A vital factor in the success of the flash baker, the carbide die and the high speed wire machine, is the modern inhibitor which has suppressed fumes, brought pickling out into the daylight, and practically eliminated dirty rods and acid brittleness. When the World War cut off immigration and we could no longer count on a supply of strong, willing, and dumb peasants to "horse around" our big wire bundles and to choke in our fume-filled pickle houses, we made wire drawing a handling problem and put it in charge of engineers, and we made pickling a laboratory job and put it in charge of chemists.

There seems to be no space to discuss copper wire, but its story of largely increased drawing speeds is not as interesting anyway.

PROTECTIVE COATINGS

By Adolph Bregman, Consulting Engineer

As it was in **1915**

ELECTROPLATING is growing, but its steps are hesitant because of the lack of fundamental knowledge. It is hoped that by the application of technical control to replace rule-of-thumb more rapid progress will be made.

Materials which are attracting wider attention are single nickel salts for nickel plating baths and prepared metal cyanides as an improvement over "home-made". Interesting reports are available on the electroplating of cobalt and the plating of lead from nitrate solutions. Warm nickel solutions are recommended for faster plating. A new mechanical plating machine has been developed to effect large reductions in labor costs in handling work.

Processes with promising futures are: Calorizing, coating steel with aluminum by heating it in the presence of aluminum powder; "rust-proofing" by treating steel in phosphate solutions; metal spraying with the Schoop pistol. Interesting work is also being done at the Bureau of Standards on copper sulphate solutions for electrotyping.

The American Electroplaters' Society is young but growing lustily. Its publication, *The Review*, has recently become a monthly. This organization bids fair to become the most powerful educational factor in the industry.

The problems of the metal finishing industry are numerous and include standardized chemicals and supplies; better cleaners for the wide variety of metals to be coated; a method of plating on aluminum; better and easier methods of analysis and control of solutions; effective coatings for plating racks. Two of the most irritating problems are the pitting of nickel deposits and the "spotting-out" of brass plated work. We need fundamental information on the effect of the condition of the basis metal on the electroplate.

And last, but far from least, we need specifications for plated coatings to protect the purchaser and user of plated articles and the conscientious, reputable producer of high grade plated products.

As it is in **1940**

DEVELOPMENTS in electroplating during recent years have been striking. In equipment and supplies we have current rectifiers and generators for low voltage; high production, automatic electroplating conveyors; rubber tank linings; the wide use of filtration and agitation; highly effective rack coatings made of synthetic resins and rubber compounds; automatic polishing and buffing machines; greaseless buffing compositions; high purity nickel anodes; degreasers.

Among the processes now in use are: Chromium and cadmium plating; electroplating on aluminum; bright nickel plating; high speed nickel and copper plating in hot solutions; electrogalvanized steel wire; heavy deposits of wear resistant nickel; electrolytic cleaning of strip steel; anodic oxidation and coloring of aluminum; electrolytic pickling and descaling; improved phosphate coatings on steel to form undercoats for paints, lacquers and enamels; electrolytic color plating; electrolytic polishing of stainless steel.

Technical control of operations is now standard practice; solutions are controlled for temperature, chemical content and pH. We can measure electroplated coatings by the microscope, the chord method, chemical dropping tests or by magnetic tests. We have widely accepted specifications for nickel, chromium, cadmium and zinc deposits on steel.

We find broad expansion of the use of metal spraying. Non-metallic coatings have progressed from amyl acetate to nitrocellulose lacquers and to synthetic resin coatings. We have hot lacquers and wrinkle finishes in wide variety.

The past few years have been fruitful in the study of fundamentals, such as throwing power, overvoltage, electrolyte films, diffusion, adhesion, X-ray structure of deposits, but many of our old problems are still unsolved. We need more work on the causes of porosity. We need a more highly protective, positive rust-proof black on steel. We still have no sure preventive of "spotting-out".

One of the most promising developments before us is the electrodeposition of tin on steel.

Typical FIRTH-STERLING "*Firsts*" in 44 years of Trail-Blazing

As one pioneer to another, Firth-Sterling Steel Company extends congratulations to the A.S.M. and METAL PROGRESS for this Silver Anniversary edition that marks 25 years ***recording*** progress in metal. For even ***more*** years Firth-Sterling has been so busy ***making*** metal progress that trail-blazing in metal has become almost a habit . . . a habit that will continue to typify our activities in industry.

After pioneering in the development of high speed steels earlier in the century, in 1908 Firth-Sterling installed one of the first two Electric Arc Melting Furnaces to be used in making Tool Steels in America . . . a revolutionary step forward in tool steel making.

During the World War, Firth-Sterling became the first American producer of Stainless Steel and continues to manufacture the finer types of Stainless for cutlery, bearings, valves and highly technical uses.

In 1928, Firth-Sterling after much independent research, and after securing a license under American patents for the manufacture of Tungsten Carbide, became a pioneer in Sintered Carbide cutting materials known as Firthite and Firthaloy. These compositions have made a well known contribution to shop practice.

In 1929, Firth-Sterling installed the first Electric Induction Furnace to be used in a tool steel plant. From a quality standpoint, the High Frequency Induction Furnace offers a real improvement over the crucible and other melting methods. Since the first of these furnaces was installed several additional units have been added and the melting capacity considerably increased by this new method.

The latest contribution to metallurgical progress is the patented method of casting ingots known as the Firth Winged Ingot process, whereby, "center-free" steel of unusual homogeneity is produced. This advanced method of casting eliminates the entire center of the ingot (containing any possible porous structure), leaving only the sounder, center-free portion of the three sections of wings to be forged into billets.

The Firth-Sterling Steel Company has its own Tungsten Mines in Colorado, which assures at all times a uniform and uninterrupted supply of Tungsten. In Tungsten Carbide the company controls all steps of the process from ore to finished tools and dies.

In 1939 Firth-Sterling acquired the American Carbide Alloys Corporation and certain rights on Titanium Carbides. This progressive step, again typifying Firth-Sterling leadership, makes available to our customers the advanced work done by both American and European organizations specializing in this new type of Sintered Carbide.

FIRTH-STERLING STEEL COMPANY

Works: McKEESPORT, PA.
NEW YORK CHICAGO
HARTFORD PHILADELPHIA
LOS ANGELES DETROIT
CLEVELAND DAYTON
GLOBE WIRE DIVISION
McKEESPORT, PA.

PERSONALS

Transferred: **Charles E. Spragg** ⊜, salesman for Jessop Steel Co., from the New York to the Boston territory.

P. P. Alexander has been elected president of Metal Hydrides, Inc., **T. Lindsley** vice-president, and **N. F. Parkinson** treasurer.

John H. Rasp has been appointed superintendent of the tool and die department of the sintered carbide division of Firth-Sterling Steel Co., McKeesport, Pa. **J. H. Chivers** has been appointed superintendent of melting for the division.

John S. Isdale, Meriden, Conn., is now representing the Ajax Electric Co., Inc., for the state of Connecticut.

The TRANSPARENT SOLUTIONS
MADE POSSIBLE BY
"Stuart's CODOL"
Liquid Grinding Compound
INSURE BETTER WORKMANSHIP
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F. N. Speller ⊜, director, department of metallurgy and research, retired March 1 after nearly 40 years with National Tube Co. He will do special consulting work in the study of corrosion problems.

Warren R. Eaton has been elected vice-president and production manager for Bliss & Laughlin, Inc., Harvey, Ill.

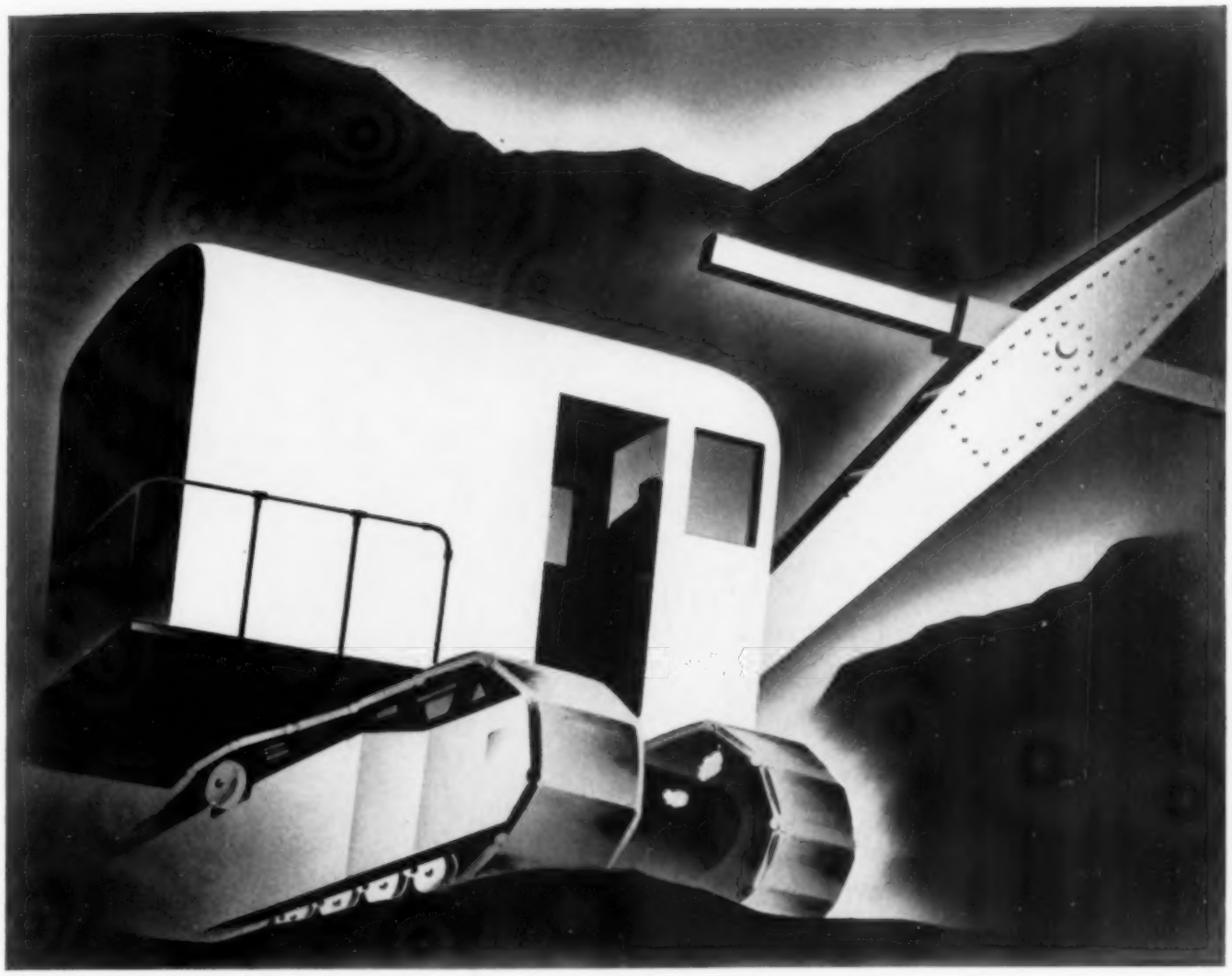
L. N. Shannon, vice-president and works manager, Stockham Pipe Fittings Co., Birmingham, Ala., has been nominated for president of the American Foundrymen's Association. **Herbert S. Simpson,** president of the National Engineering Co., Chicago, has been nominated for vice-president. New directors nominated are: **Henry S. Washburn, George W. Cannon, L. P. Robinson, Harold J. Roast** ⊜, and **B. D. Claffey.**

J. M. Cosgrove, formerly chief chemist of Noblitt-Sparks Industries, Inc., has been appointed director of the development laboratory for Standard Steel Spring Co., Coraopolis, Pa.

H. Kenneth Briggs, one-time ⊜ assistant secretary, formerly metallurgist for Western Foundry Co., is now with Miller and Co. of Chicago, handling products of the Woodward Iron Co., Tonawanda Iron Co., and a complete line of pig iron, silveries, ferroalloys and coke.

L. R. Westbrook, formerly assistant director of the Cleveland experimental laboratory of the Grasselli Chemicals Department, E. I. du Pont de Nemours & Co., has been appointed research manager of the company's Electroplating Division.

W. Woodward Williams and **Perry Kilsby** have formed a new partnership with offices in Los Angeles, representing Babcock & Wilcox Tube Co., Sivyer Steel Casting Co., Wm. F. Klemp Co., and Pittsburgh Crucible Steel Co.



STAMINA TO SPARE

When it comes to power shovels, "heavy duty" means just what it says. They must have stamina to spare. And that is the reason a leading shovel manufacturer has adopted Molybdenum steels for many vital parts.

Driving clutches, swing drum bevel gears and shipper shaft pinions, for example, are made of Manganese-Molybdenum cast steel, chosen because: it develops the requisite toughness and hardness; it responds readily to various heat treatments to produce different physical properties to meet various requirements; it is comparatively inexpensive.

If you are casting steel for any purposes you should have a copy of our technical book, "Molybdenum in Steel," which gives complete practical data on Manganese-Moly and other Molybdenum cast steels. It is sent free on request to engineers and production executives interested in modern materials for modern needs.

PRODUCERS OF MOLYBDENUM BRIQUETTES, FERRO-MOLYBDENUM, AND CALCIUM MOLYBDATE

Climax Mo-lyb-den-um Company
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MOLY

PERSONALS

J. O. Kilian ⊜, associated with A. M. Castle & Co. for 17 years as sales engineer, is now sales engineer for the American Rolling Mill Co. in Los Angeles.

H. L. Baer ⊜ is now president of the Tempil Corp., New York City.

Oscar E. Harder, vice-president ⊜ and assistant director of Battelle Memorial Institute, will present the 14th annual series of Priestley Lectures at Pennsylvania State College to be held March 11 to 15.

Earl Beyerlein ⊜, formerly metallurgist for the David Bradley Mfg. Works in Bradley, Ill., is now metallurgist for the Hansell-Elcock Co., Chicago.

AMPCO METAL
IS OFTEN THE ANSWER

IF you require a non-ferrous alloy that provides the utmost in wear resistance — tensile strength — corrosion resistance . . . then you have a job for Ampco Metal.

Time and again — for hundreds of manufacturers, Ampco Metal has proved its value in a wide variety of applications, ranging from cams, shifters, nuts, gears, bushings and bearings, to forming and drawing dies and acid resistant equipment. Time and again it has proved its ability to outlast other alloys in difficult services — that it can actually outwear hardened steel.

In some one of its six grades Ampco Metal can probably solve a problem for you — why not check with us.

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Elected chairman of the Iron and Steel Division, American Institute of Mining and Metallurgical Engineers: **Frank T. Sisco** ⊜, editor, Alloys of Iron Research of the Engineering Foundation; elected chairman of the Institute of Metals Division: **Edmund M. Wise** ⊜, metallurgist, Research Laboratories, The International Nickel Co., Inc.; elected vice-chairman of the Mineral Industry Education Division: **Robert F. Mehl** ⊜, director, Metals Research Laboratory, Carnegie Institute of Technology.

Transferred by Procter and Gamble Co.: **Joseph H. Walter, Jr.** ⊜ from the Staten Island factory to metallurgist in the engineering division at Cincinnati, Ohio.

Richard F. Harvey ⊜ has resigned from the Simonds Saw & Steel Co. to accept a position with Brown & Sharpe Mfg. Co.

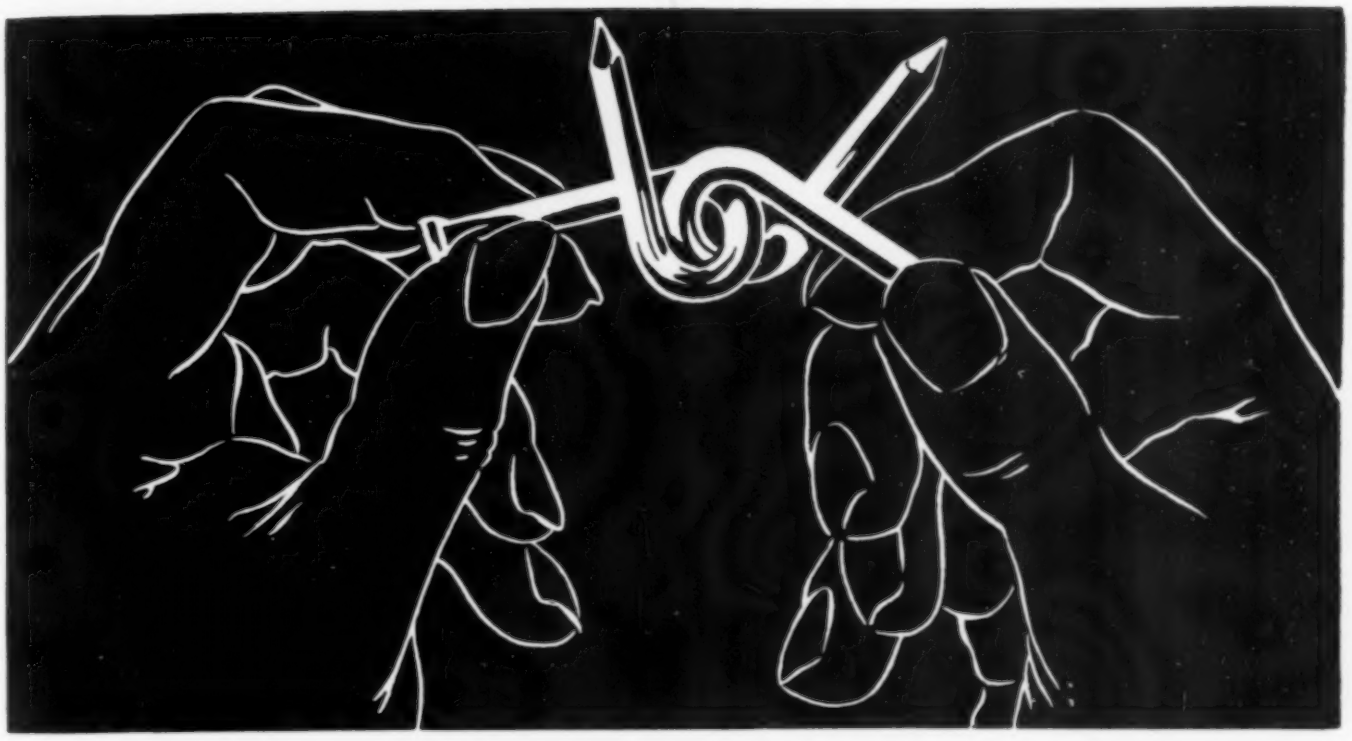
Arthur E. Broady ⊜, formerly assistant superintendent of the research department, The Midvale Co., is now metallurgist for the Railway Steel Spring Division of American Locomotive Co., Latrobe, Pa.

Harry B. Parker ⊜ has been made metallurgist for the Tubular Rivet & Machine Co., Wollaston, Mass.

Wallace Reen ⊜, formerly in the test shop of Crucible Steel Co. of America, Sanderson Branch, is now junior research metallurgist with Allegheny Ludlum Steel Corp., Brackenridge, Pa.

Arnold L. Rustay ⊜, formerly metallurgist at Bliss & Laughlin, Inc., Harvey, Ill., is now metallurgist at Wyman-Gordon Co., Worcester, Mass.

Transferred by Climax Molybdenum Co.: **Harold Blackett** ⊜, from the Detroit plant where he was assistant metallurgist in charge of physical testing, to the mine and mill in Climax, Colo., as metallurgical test engineer.



What is the CORRECT SOLUTION?

Finding the correct solution to your heating problem is a real puzzle. But—just like the bent nail tickler—there is a correct way to handle it.

This way is to call in a Flinn & Dreffein engineer—a master puzzle-solver who has licked some of the most baffling problems in the furnace industry.

The problems we have solved for varied manufacturers in the past 33 years have given us a store of knowledge which is at your immediate disposal. During this time we have built more furnaces for the sheet mill—where surface control is so exact—than any other furnace manufacturer.

We can build the furnaces below just as well. Write us a letter outlining your problem—we'll be glad to offer a practical suggestion at no obligation.

annealing . . . billet heating . . . bright hardening . . . controlled atmosphere . . . carburizing . . . scale-free annealing . . . drawing . . . short cycle malleable annealing . . . forging . . . hardening . . . normalizing . . . continuous conveyor furnaces for sheet mills . . . continuous normalizing furnaces for sheet mills.

Pack Furnace Built and Installed at Algoma Tinplate Mill.

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308 WEST WASHINGTON ST., CHICAGO, ILLINOIS

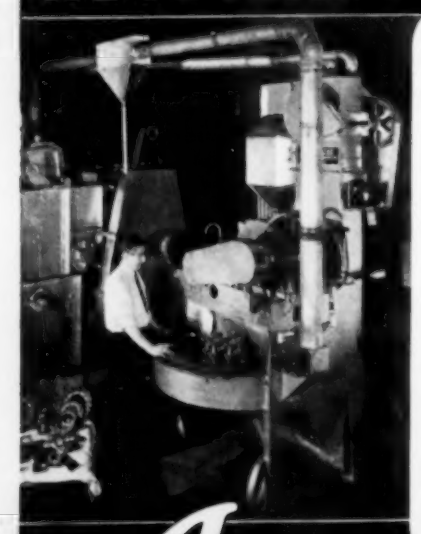
PERSONALS

George Bitzer, sales engineer for Forging and Casting Corp., has been placed in charge of a newly opened district office in Cleveland.

George E. Hallenbeck is now associated with Baker Brothers, Inc., Toledo, Ohio.

Charles F. Burrows, who recently graduated from Case School of Applied Science with a degree of M.S. in metallurgical engineering, is employed as metallurgist at Glenn L. Martin Co. in Baltimore.

Henry O. Steinmetz, formerly flotation helper at the Utah Copper Co., is now an observer at the Park Works of Crucible Steel Co. of America in Pittsburgh.



A prominent motor car manufacturer's* experience with WHEELABRATOR machines led to the purchase of another unit recently despite the fact that it was not provided for in the 1940 budget. The purchase requisition read: "Not included in the 1940 program, *but an improvement necessary for quality.*"

That is one of the reasons why so many plants are changing over to *WHEELABRATING*—it is *perfected* airless abrasive blasting at its best. Nearly 900 installations have been made in the last six years.

*Name on request.

THE American FOUNDRY EQUIPMENT CO. 511 S. BYRKIT ST. MISHAWAKA, IND. CABLE ADDRESS: APECO

OFFICES IN ALL PRINCIPAL CITIES

Richard P. Evans has discontinued service with Wm. Jessop & Sons in Chicago to enter the sales department of the Carpenter Steel Co. in the New York metropolitan area.

Myron L. Meyers, formerly chief metallurgist of United Shipyards, Inc., has joined the technical staff of the Beetle Products Division of American Cyanamid Co., Bound Brook, N. J.

Louis Haberman has been temporarily transferred from the metallurgical department of the Torrance Works, Columbia Steel Co., Torrance, Calif., to the research laboratory, United States Steel Corp., Kearny, N. J., for metallurgical research training.

Appointed chief chemist in charge of the chemical laboratory and metallurgical laboratory of the new electric alloy steel division of the Copperweld Steel Co. at Warren, Ohio: **Roy F. Lab**, formerly metallurgist with Barium Stainless Steel Corp., Canton, Ohio.

Transferred: **Sheldon H. Reynolds**, from National Works, National Tube Co., to research laboratory of United States Steel Corp., Kearny, N. J.

John A. Mathews, Jr. has left Egleston Bros. of New York and is back with the Crucible Steel Co. of America at the Park Works in Pittsburgh.

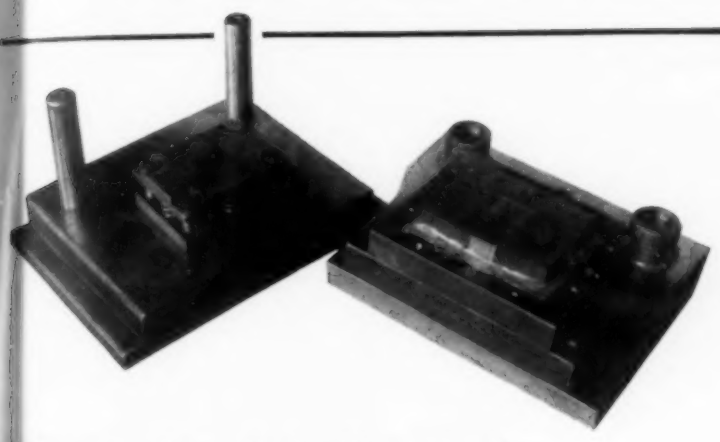
Vernon C. Robinson, formerly in the laboratory department of the Saginaw Malleable Iron Division of General Motors Corp., is now with the process control department of the Gary Works, Carnegie-Illinois Steel Corp.

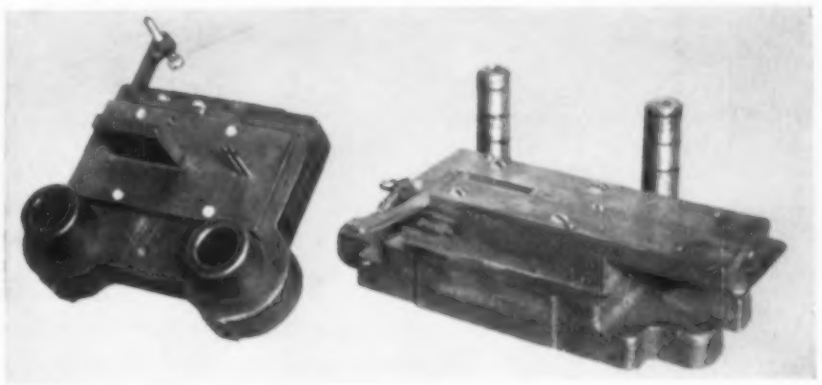
Ray Leake, formerly employed at the Granite City Steel Co., is now an openhearth observer at the Gary Works of Carnegie-Illinois Steel Corp.

W. L. Kennicott has been made Los Angeles manager for McKenna Metals Co.

NEW WESTINGHOUSE FURNACE BRIGHT HARDENS DIE BLOCKS

Without Oxidation, Decarburization, Distortion or Cracking





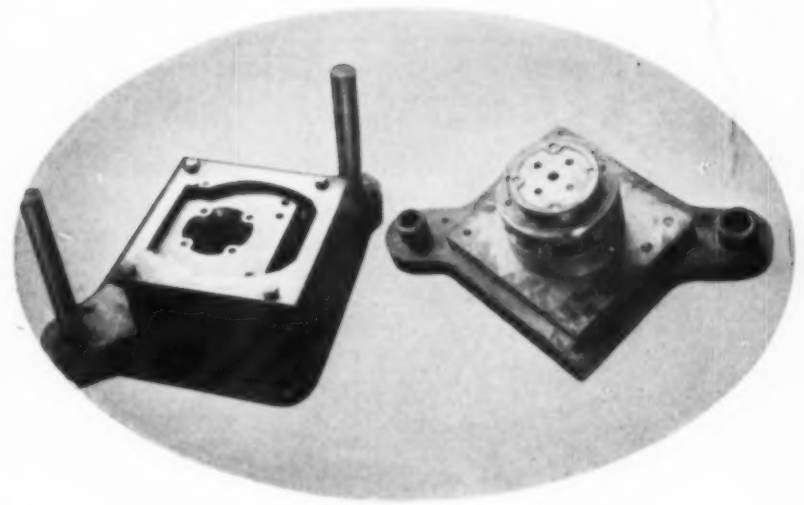
Expensive Grinding and Finishing Operations Eliminated

It has always been an accepted fact that damage to die blocks during hardening can not be avoided. This is now an old idea. Damage *can* be avoided. Die blocks can be bright hardened without oxidation, decarburization, distortion or cracking. Dies can be produced without expensive grinding or finishing operations. Production costs can be reduced without any loss in precision or quality.

Westinghouse research has revealed the causes of damage to die blocks during hardening. Westinghouse engineers have designed a furnace that eliminates these causes.

The new electric furnace is of entirely different construction and design to permit the use of a newly developed atmosphere, "Ammogas." Heated by this new electric furnace in Westinghouse Ammogas, die blocks harden with bright, clean, smooth surfaces.

Wherever dies are hardened, this new furnace can cut production costs. For full information see your Westinghouse representative, or write direct. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



An outstanding advantage of Ammogas hardening is the complete assurance that a die set will come from the hardening room in a serviceable condition. The die sets illustrated here are typical of more than 300 punches, dies and other tools hardened for production departments during the past 28 months

J-10154-A

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Complete Heat Treating Equipment

YOU CAN DEPEND ON McKEE

PROPORTIONAL MIXERS FOR ABSOLUTELY ACCURATE AIR-GAS PROPORTIONING

(Single-valve — automatic or manual control)

Accurate air-gas mixing whether for a tiny single pilot burner, or
A LARGE PREMIX SYSTEM FOR A WHOLE PLANT — Write for catalog "L"

Let our gas engineering specialists analyze your gas-mixing or gas-burning problem.
ANALYSIS AND RECOMMENDATIONS FREE — just send us details of your problem.
Recommendations for New Installations, or for conversion of existing equipment.

← SERIES "LP" McKEE MIXER
A simple single-valve mixer and control —ideal for a multiplicity of applications.
(Described in our bulletin L-3)

Write today!

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PYRO THE SIMPLIFIED OPTICAL PYROMETER

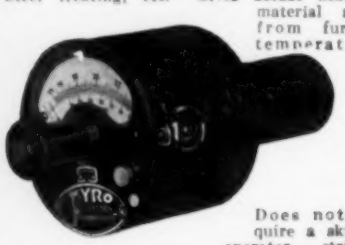
YOU CANNOT AFFORD NOT TO OWN ONE!

Because it eliminates guesswork, waste and spoilage; it pays for itself quickly. PYRO is *a self-contained, DIRECT READING, sturdy unit* made to stand rough use but it is absolutely *accurate* and *dependable*.
Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects, or smallest streams; no correction charts, no accessories, no maintenance expense. Special "FOUNDRY TYPE" has, in addition to its standard calibrated range, a red correction scale determining TRUE SPOUT and POURING TEMPERATURES of molten iron and steel when measured in the open.

Stock ranges 1400° F. to 5500° F.

PYRO RADIATION PYROMETER

The ideal instrument for Furnace, Kiln or Steel treating, etc. Gives actual heat of material aside from furnace temperature.



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FORGING, HEAT TREATING, METAL MELTING, ETC.

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THE FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTRY

GA X-ITE GA O'ALLOYS GA X-ITE GA O'ALLOYS

QUARTER CENTURY OF FURNACE PROGRESS

In no field of industrial equipment has there been greater progress than in furnace engineering.

The modern industrial furnace, literally a "heat treating machine," owes its development to heat resistant alloys, and modern alloy engineering. Hundreds of industrial plants would gladly prefer to pay ten times the cost of their alloy furnace parts than do without mechanical furnaces.

General Alloys Co. is recognized as the outstanding leader in alloy casting and engineering. **The obligation of such leadership is progress** and—the penalty is price competition from those who have no contribution to offer.

Wherever furnace parts, heat treating containers or any heat or corrosion resistant castings are used—most discriminating users, including the world's largest heat treats, specify and insist upon General Alloys castings—First, for absolute dependability; Second, for Engineering and Metallurgical superiority; and Third, for maximum service at minimum cost per heat hour.

Men of A.S.M. have made it possible through their patronage and technical contributions for this company to gain the **EXPERIENCE** on which **we solicit your inquiries.** To them we extend our most sincere thanks and for the next quarter century we pledge Alloy Progress.

General Alloys Company, Boston

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IS YOUR NAME ON THIS LIST?

This is a partial list of industrial users of Globar Brand High Temperature Heating Elements. It is eloquent testimony to the way a great many heating processes have benefited from the use of high temperature electric heat since the introduction of Globar Brand Heating Elements, sixteen years ago.

We earnestly suggest that you consider the many benefits to be derived from the use of "Globar" in your present operations or in the development of new processes which might otherwise be impossible.

Our engineers will be glad to discuss with you the possible uses for high temperature electric heat in your plant.

Globar
REG. U. S. PAT. OFF.

DIVISION OF

THE CARBORUNDUM COMPANY
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Niagara Falls, N. Y.

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HYDRYZING *eliminates "soft-spot" troubles due to scale*

● If your carburized parts show erratic hardnesses on reheating and oil quenching chances are that much of the trouble is due to scale adhering to them and preventing the quench from "taking hold." Scale forms an insulating blanket and because oil will not "throw" the scale as does a water quench, spotty hardening very often results.

To insure maximum and uniform hardness, the parts should be protected against scaling and decarburizing, and the Hydryzing process does just that. Scale cannot form regardless of how long the work may be in the furnace, and as a result it goes into the quench tank *clean*, quenches rapidly and uniformly so that soft spots due to scale are completely eliminated. And, of course, eliminating scale gets rid of pitting, so that grinding tolerances can be reduced many thousandths. And because the Hydryzing atmosphere does not rob the surface of carbon, your parts are fully and uniformly hard right to the surface.

In addition to turning out work free from scale, decarb, or carburization, Hydryzing is ideally simple. Thus, thoroughly dependable results are assured because the atmosphere is right for all steels, and no experimentation is required. It's easy to prove to yourself the many advantages of Hydryzing. Just send us samples of your work. We'll Hydryze and return them to you immediately for inspection.

Pictured above are results of tests in which 1315X rounds, 1", 1¼", and 1½" dia. x 3" long were carburized and one of each size hardened from the open fire, and one of each from the Hydryzer. All parts were in the 1500° hardening heat for the same length of time, and all were oil quenched in the same manner. In checking hardnesses on the open fire hardened parts scale was polished off so it would not affect hardness readings. Hardness readings for Hydryzed parts were made directly on the surfaces with no polishing. As is evident, the oil quenched hydryzed parts are uniformly hard because they quenched rapidly and uniformly. With open fire hardening the heat treater must often resort to water quenching with its attendent distortion problems.

HYDRYZING FOR HARDENING

LINDBERG ENGINEERING CO.

222 North Laflin Street • Chicago, Illinois

CYCLONE FOR TEMPERING

BLAST FURNACES

(Continued from page 298)

deposition in relation to its effect upon proper blast furnace performance.

The larger capacity of furnaces is reflected to some extent in greater life of the lining. Today, the average total production on a lining is approximately 750,000 gross tons, although several furnaces have crossed the million-ton mark for a single campaign.

Blast furnace gas, mostly in its raw state, is utilized in stoves and under boilers. Simple tower washers have been introduced to process the gas intended for consumption. Gas cleanliness obtainable is about 0.5 grains per cu.ft.

Gas cleaning by means of electrical precipitation is being studied, although it is viewed with skepticism by many. Secondary cleaning is confined to gas used in internal combustion engines for generating blast or electricity — of which a substantial number is installed, because of their somewhat greater fuel economy in comparison with steam operated engines.

Hot blast stoves generally use checkers with about 9-in. openings. A few plants with adequate gas washing equipment have been able to increase stove capacities by decreasing checker openings to 6 in. or slightly less. Four stoves and more are commonly used for each furnace, permitting blast heats running up to as high as 1300° F.

Nearly all blast furnaces are equipped with single barrel, hand operated steam guns for closing the iron notch. It is proposed, however, to experiment with a gun having remote controls.

Among the many successive processing steps required to convert iron ore into finished steel goods, blast furnace smelting is respected as the most hazardous and unpredictable. Its importance as the major source of metal for the steel plants and of power for the mills is being recognized, yet little is being accomplished toward avoiding the frequent and major irregularities in blast furnace performance which upset entire steel manufacturing schedules.

What's What in *Temperature Control*

A bewildering question to instrument users, to say the least, and not without foundation when the unprecedented progress made in control instruments in the last decade is taken into consideration.

Simultaneous with the rapid and continuous rise in control standards, came a barrage of ever confusing claims of the instrument manufacturers. Yet, up to five years ago differentiation of little consequence could be made—all control instruments being mechanical in design.

At this time a new principle was introduced. It was, and still is, far advanced in both design and results. Devoid of depressor bar mechanisms, motors, gears and other moving mechanical parts, which are indispensable in the mechanical type instrument, this new principle completely eliminates all lag time between temperature deviation and complete control.

This principle is the Wheelco "Radio Principle" electronic control system, since proved in actual service in all branches of industrial control applications, including: "ON-OFF", Proportioning, Program Control. etc.

It is easy to reason why this system permits the closest control possible under any method, when it is realized that there are no parts to be set in motion before control can be effected, nor parts to wear, stick or otherwise interfere with control accuracy.

Complete detailed information on the "Radio Principle" Electronic Control System may be had by writing to the Wheelco Instruments Company, 1933 South Halsted Street, Chicago, Illinois.

BLAST FURNACES

(Continued from page 298)

various furnace levels have furnished the basis for rational analysis and corresponding changes in design.

The substantial enlargement of furnaces together with smoother operation and improvement in quality of refractories have contributed jointly to a pronounced extension of lining life. Total tonnages on a lining of over 2,000,000 gross tons are no longer uncommon and one furnace recently finished a campaign after having produced very close to 3,000,000 gross tons of pig iron.

Practically the entire gas produced in blast furnaces is passed through primary washers, with some modern primary washers capable of reducing the solids contained to 0.15 grains per cu.ft. Secondary gas cleaning facilities, including electrical precipitators, disintegrators, and auxiliary equipment, have been developed and furnish gas with a cleanliness of 0.01 grains of solids per cu.ft. and under. Nearly all gas produced is consumed, either in stoves, under boilers, or for heating or melting operations. Steam turbine development has overtaken the gas engine era, with improved efficiency due to design and increased steam pressures and temperature, permitting use of large generator units with superior over-all economy.

Clean gas has permitted a reduction of checker openings — down to 1½ in. The present trend is towards a limit of three stoves, even for the larger furnaces. Blast temperatures of 1600° F. are obtainable.

Every modern furnace is equipped with a remote controlled, electrically operated gun.

Scientific understanding has been successfully translated into practical process control so that blast furnace operation today ranks first among the metallurgical processes of the steel industry in economy, reliability, and in the successful control of the hazards to life and limb, which necessarily follow man's endeavors to harness for his benefit the natural resources and energies of this earth.

CIRC-AIR

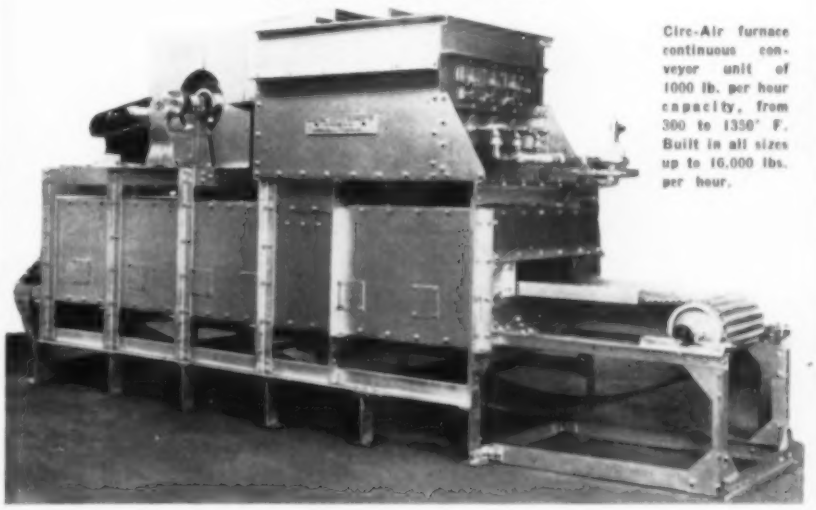
Widely Used IN BOTH INDUSTRIES — FERROUS & NON-FERROUS

Circ-Air furnaces are being widely used for heating aluminum for forging or extruding; heat treating aluminum; annealing, coloring, sweating and soldering of brass parts; bluing of steel parts; drawing or tempering all kinds of steel parts—coil or leaf springs, bolts, nuts, tools, etc.; stress relieving of cast iron and welded parts, and many other heating operations.

Circ-Air furnaces are now available in a complete range of sizes, styles and capacities; horizontal batch type units in 25 standard sizes; vertical batch type units in 10 standard sizes; continuous conveyor units (similar to that shown below) in all sizes ranging from 18 to 96 inches wide, 8 to 80 ft. long and capacities from 200 to 16,000 lbs. per hr.; also batch or conveyor units in special sizes to meet unusual requirements.

Whether your heat treating requirements call for continuous production heat treatment or the heat treatment of miscellaneous individual parts—at any temperatures from 250 to 1350 deg. F.—there is a CIRC-AIR furnace that will do the job accurately and economically.

Write for Bulletins 6 and 7

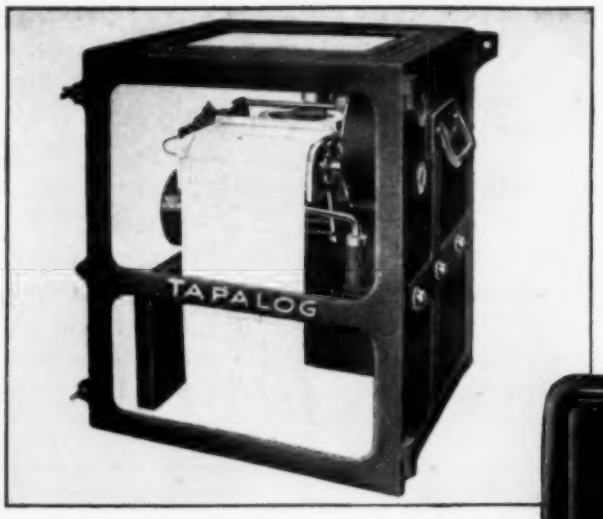


Circ-Air furnace continuous conveyor unit of 1000 lb. per hour capacity, from 300 to 1350° F. Built in all sizes up to 16,000 lbs. per hour.

INDUSTRIAL HEATING EQUIPMENT CO.

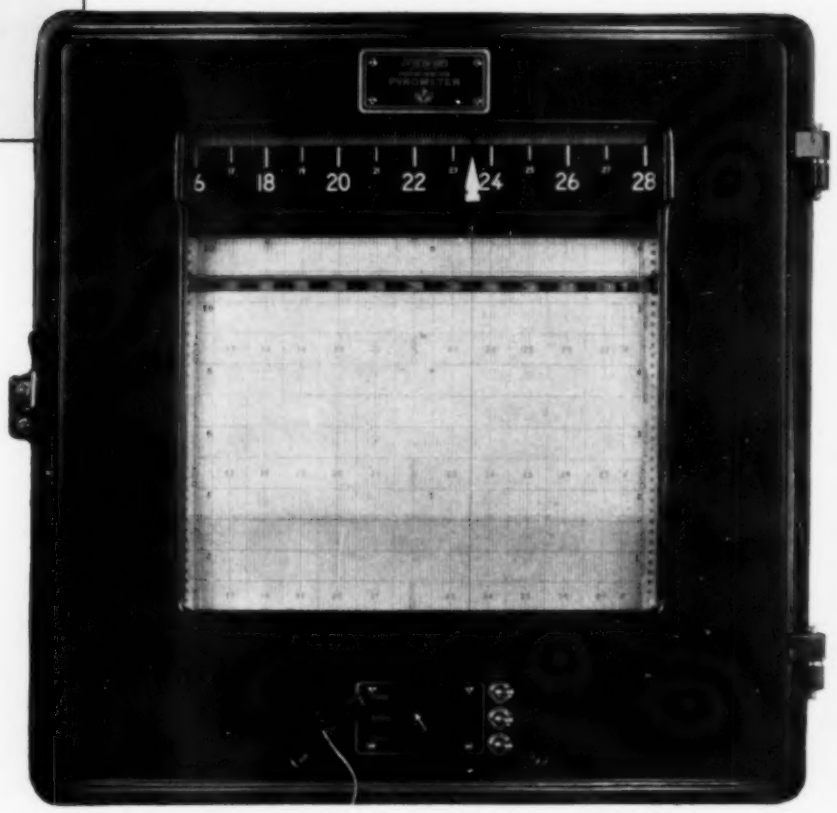
Manufacturers of Industrial Furnaces and Oil Burners Since 1917

3570 FREMONT PLACE DETROIT, MICH.



First in 1914

The Tapalog — first multiple recording pyrometer built in the United States. Its *practical performance* under actual conditions of plant operation set a course for a quarter-century of progress in industrial pyrometry.



First Choice in 1940

Foxboro's latest achievement in the same "*practical performance*" tradition — a pyrometer-controller with indicating and recording functions — a clear "first" in sensitivity of detection, in flexibility of control action, and in adaptability to critical furnace conditions or processing requirements.

Over the past quarter-century, metallurgical progress and advancements in pyrometry have been so closely allied — so inescapably interdependent — that it has become impossible to separate their respective contributions to industrial achievement and modern ways of living. Thus, without attempting to isolate its own part in the advance, Foxboro takes pride in its continuous association with those who have taken the lead in improving metallurgical techniques, in raising the properties of metals and lowering the costs of manufacture.

After all, an "improved" instrument cannot be designed in a vacuum—it must lead to a practical advance in its intended industrial application, or stay on the shelf. The way to verify instrument progress, then, is not by the additional intricacies within the case, but by the improved performance of well instrumented plants. That is why Foxboro knows no better evidence of its own achievement than the fact that, in plants throughout the nation, new advances in metallurgy are continually being made because of the higher standards of accurate measurement and precise control which Foxboro instruments have made available. **The Foxboro Company, 52 Neponset Avenue, Foxboro, Mass., U.S.A.** Branch Offices in 25 Principal Cities.

FOXBORO

REG. U. S. PAT. OFF.

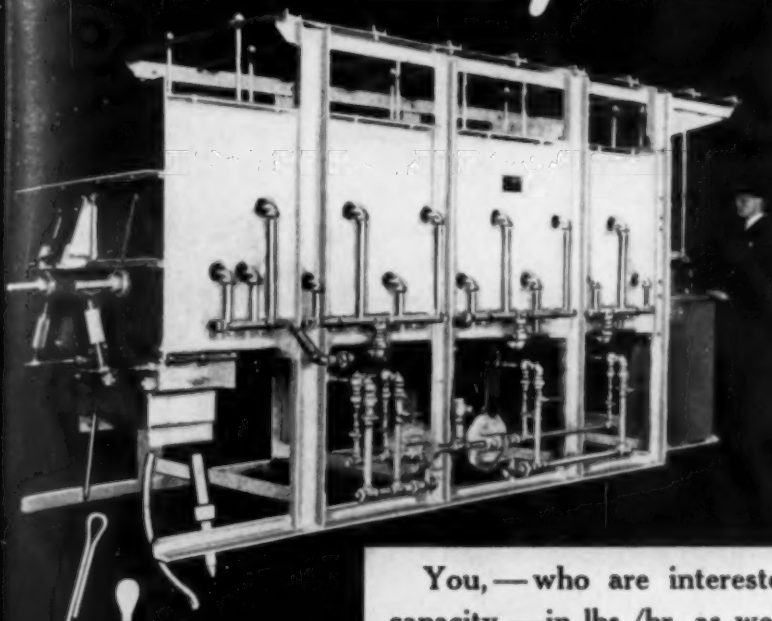
RECORDING | CONTROLLING · INDICATING

Instruments

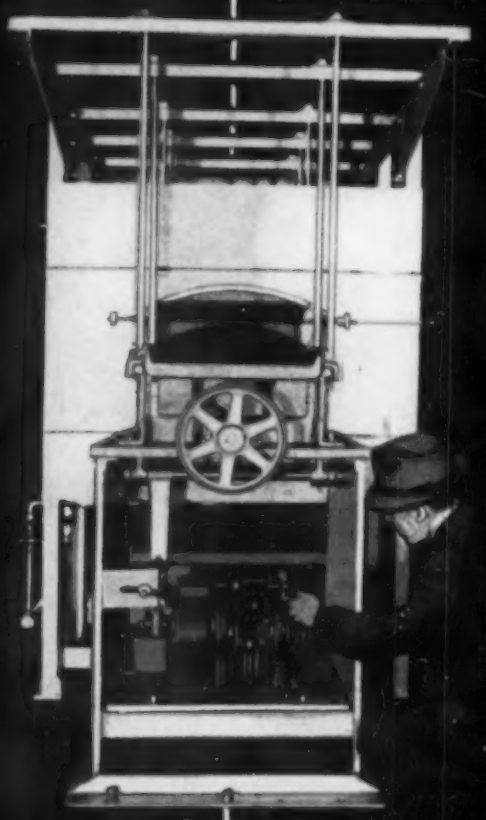
Certified ACCURACY RESPONSE

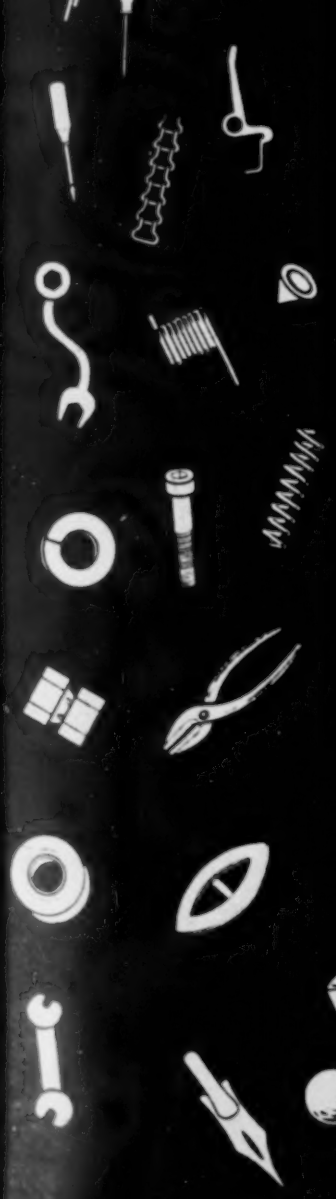
TEMPERATURE · LIQUID LEVEL
PRESSURE · FLOW · HUMIDITY

Work only enters and leaves--



the heating chamber of this latest and largest reciprocating hearth Heating Machine.



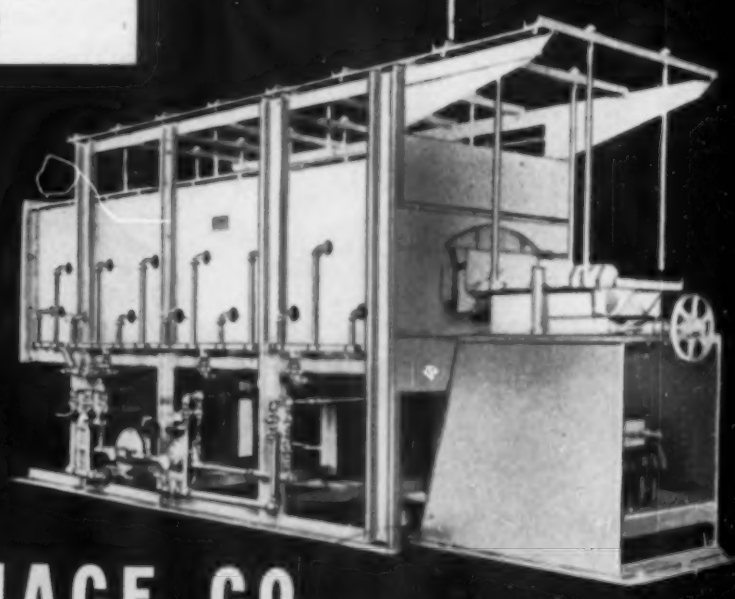


You,—who are interested in greater capacity,—in lbs./hr. as well as lbs./$—will welcome this new production tool.

The patented external drive, uniformly conveys your work pieces through the heating zone by their own momentum. By a twist of the wrist, the number, force and extent of the strokes are varied to adapt the machine to loads ranging from phonograph needles and ball bearings—to pieces weighing 10 lbs. each.

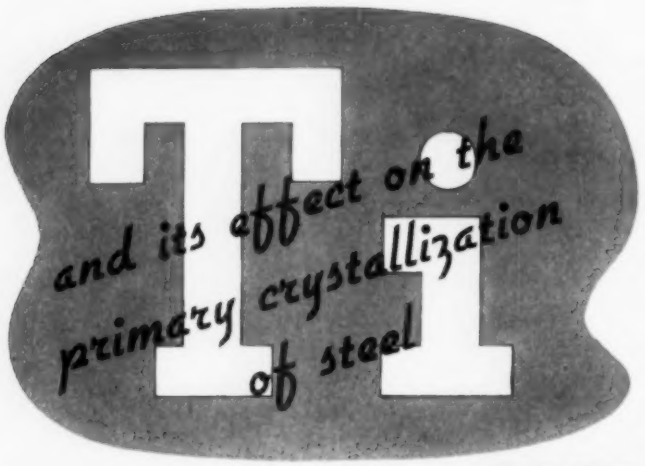
Maintenance problems, heat losses and thermal gradients are reduced to a minimum through the elimination of conveying mechanisms from the heating chamber. A uniform, clean and efficiently heat treated product results.

Let's Hear From You!



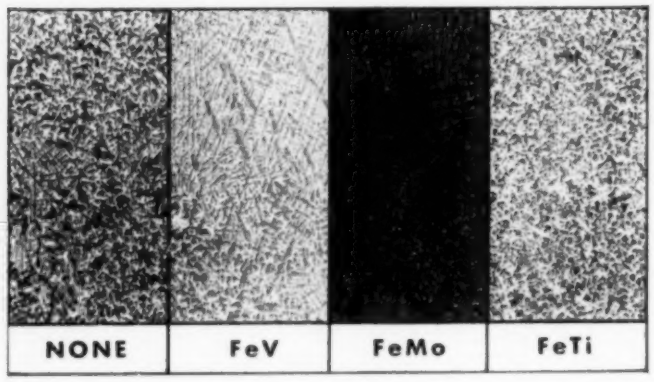
AMERICAN GAS FURNACE CO.

ELIZABETH, N. J.



TITANIUM PROVIDES A SIMPLE PROVEN WAY TO PRODUCE STEELS WITH A FINE GRAIN STRUCTURE

THE MERIT MARK OF METAL TAM



The macrographs above show the effects of different alloy additions on test ingots of .40 carbon steel made under identical conditions.

Of principal interest is the varying character of the dendritic crystals and the fact that each steel shows a well developed dendritic structure, except for the one treated with Ti where the dendrites are short, mostly nodules. This is the result of the influence of Titanium on primary crystallization which alters the mode of solidification, producing a larger number of centers of crystallization and a finer grain throughout the ingot.

Titanium is produced for your use by the Titanium Alloy Manufacturing Company, in several analyses of alloys, each designed for a specific application. Why not call in a TAM Engineer to explain? Titanium Alloy Manufacturing Company, Niagara Falls, N.Y., U. S. A.

Look to
TAM
for better metals

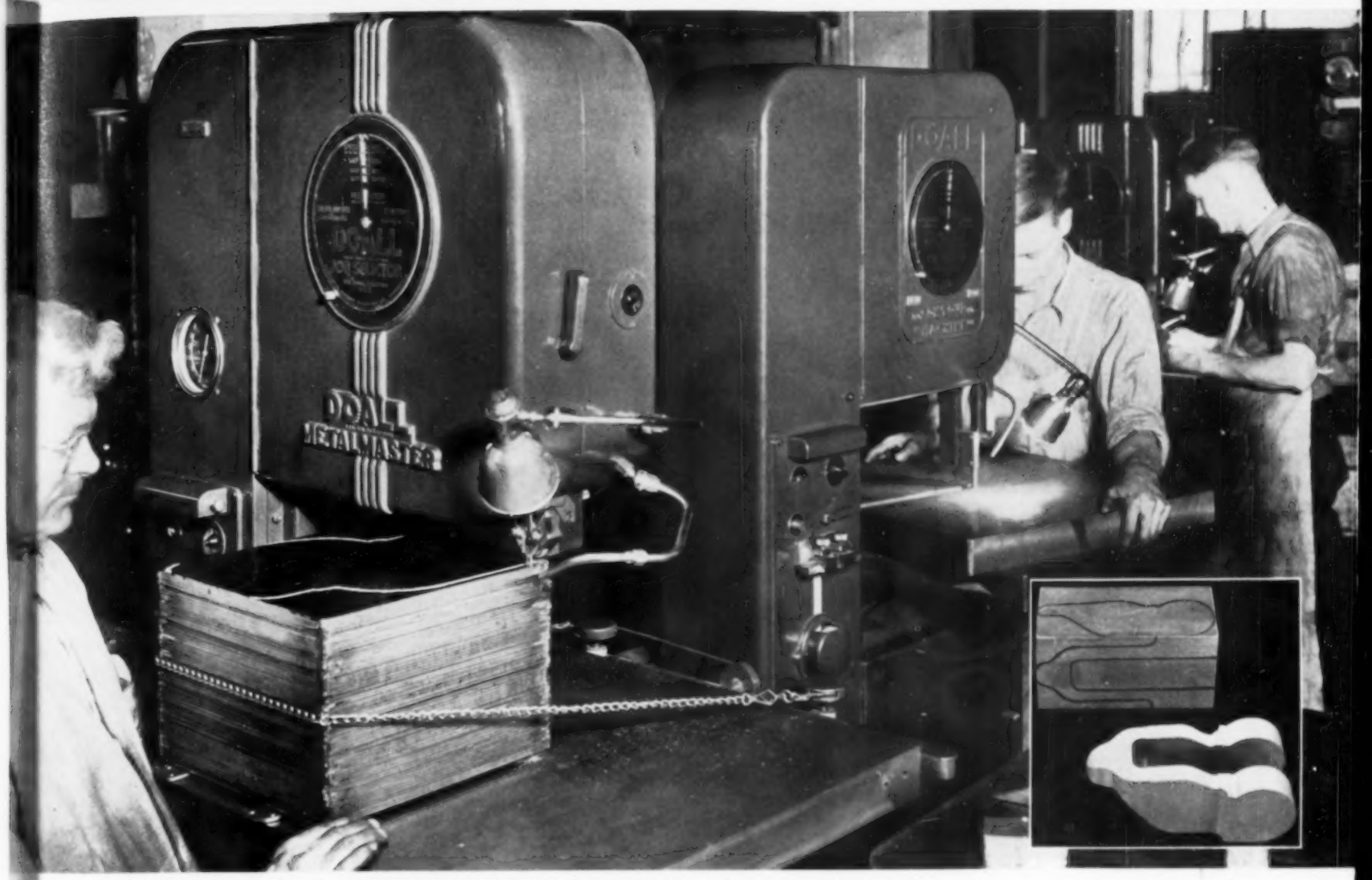
CASTINGS

(Continued from page 305) have swung notably toward electric arc furnaces and even to high frequency induction furnaces for the high alloy types.

About 20 years ago was published Storey's work on the principles of malleable annealing and Touceda's discussion of the general characteristics of what are now called pearlitic malleables, which then had not reached industrial significance. Metal between about 0.60% carbon and about 2.2% carbon was considered useless in any form of casting and had not been investigated. Pearlitic malleables have now been applied in a number of directions and so commend themselves to many well informed engineers. A whole range of "graphitizable" steels having carbons in the approximate range from 1.0 to 1.7% and silicons around 1.5% are being tried out in large scale production — usually in a partially graphitized state, though they are useful when completely graphitized also. Annealing times have been reduced from the seven to ten days, common a quarter-century ago, to something like three to five days in economical types of furnaces — and at additional costs to still lower times for certain special materials.

Twenty-five years ago a few electric furnaces were used in the triplex process for making malleable; electric furnaces are still used in a few malleable foundries, though not by those who pioneered the process. Gray iron is predominantly a cupola product, as ever; some very superior articles are made from air furnace gray iron (as they have for a century, more or less); electric furnace gray iron — plain and alloyed — is now also a commercial product.

Molding machines have greatly developed and are universally used in some form by all foundries of any considerable size. Mechanization in the direction of the automatic handling of sand, molds, molten iron and castings has been carried far — in the larger units especially where repetition work is the rule. Synthetic molding sands, which were originated and used for some time only in steel foundries, have been studied by gray iron and malleable foundries, and methods developed to bring and keep them to certain desirable standards of quality by suitable preparation.



DOALL contour machines set up for (left to right) cutting, filing and polishing. Inset: poppet lever sawed out of steel block and filed by DOALL. Courtesy Continental Machines, Inc., Minneapolis, Minnesota.

A GOOD IDEA ON PAPER BECOMES A WHIZ IN STEEL

● Last decade's development of alloys such as chromium and molybdenum made possible saw blades as narrow as 1/16-inch for cutting metal . . . gave promise of a gala comeback for the band saw—star of the lumber show at the World's Fair in '98. The idea of these new, tough, slender saws was good—on paper. How to make them actual cost cutters for the average shop was the problem.

For six years, the metal-cutting band saw went through the development mill. One improvement after another came until finally it seemed that the ideal model had been attained. It was made of seasoned castings. It worked perfectly. But it was still in the luxury class.

Then Doctors of Design went to work on the problem with *"Shield-Arc"* welded steel construction. They developed a rigid, strong, light-weight machine that produced more uniform work at less cost. (*The welded steel "Model V-16," does three times as much work as the "Model J" it replaces.*)

Result: This versatile "contouring" machine, now profitable for the average shop, is revolutionizing many machining practices for lower costs. A good idea on paper becomes a whiz in steel . . . and in sales.

"Shield-Arc" welding has turned good ideas into profits in thousands of similar cases—in manufacturing, construction and maintenance. Try this method of uniting design ingenuity with superior materials and see how it makes *your* products *stronger, more rigid, better looking* with savings in weight, time and money.* Counsel of experienced Lincoln engineers is yours for the asking. Phone the nearest Lincoln office or write THE LINCOLN ELECTRIC COMPANY, Dept.MM **6**, Cleveland, Ohio. Largest Manufacturers of Arc Welding Equipment in the World.

LINCOLN *"SHIELD-ARC"* WELDING

Unites design ingenuity with superior structural materials for progress.

THEY BOTH HAVE IT — Both *"Shield-Arc"* and *"Shield-Arc Jr."* Welders have Continuous Self-Indicating "Job Selector" (assuring the right TYPE of arc) and Current Control (assuring the right AMPERAGE) for lowest costs on every job. Get free bulletin on these New Lincoln Welders.

* **FOR EXAMPLE**, Standard steel shapes and pressed steel parts simplify production of DOALL machines. Eliminate patterns and expensive time-consuming steps. Accurate assembly by welding limits machining operations to a quick grinding. Result: Faster production. Lower costs.

FASTER FILLETS. Users of the new "Fleetweld 8" report 10% to 30% faster fillet welding with this smooth-flowing Lincoln Electrode. For positioned and non-positioned flat fillets. Ask for free procedure bulletin.

HELPFUL LITERATURE

● ***Some of the foremost experts in the metal industry have contributed to the wealth of information contained in the literature described on this page. You will find your time well spent in looking it over. One booklet may solve your most difficult problem. Use the convenient coupon today to obtain this free literature.***

Non-Sparking Safety Tools

If your work is near inflammable gases, explosives, etc., the new 20-page catalog featuring Ampco non-sparking safety tools will prove interesting and valuable. Ampco Metal, Inc. Bulletin Bd-175.

Dilatometer

The new Rockwell-Bristol Dilatometer which both indicates and records in ink time-dilatation changes and temperature-dilatation changes simultaneously during heating and cooling cycles is described in a folder released by the Bristol Co. Bulletin Bd-87.

Contour Sawing

A virtual text on Contour Sawing, containing over 300 illustrations in its 160 pages, is now available through Continental Machines, Inc. Bulletin Bd-170.

Structural Metal

A complete and concise discussion of magnesium and its alloys is contained in the booklet "Industry's Lightest Structural Metal" which is made available through the Dow Chemical Co. Bulletin Bd-215.

Heat Treating Hints

A helpful, colorful booklet edited by experienced heat treaters is available through the Lindberg Engineering Co. Bulletin Bd-66.

Flame Gouging

An economical method of grooving steel "Flame Gouging", is explained with operating data and illustrations in an 8-page folder released by The Linde Air Products Co. Bulletin Bd-63.

Machinability Chart

A quick and accurate picture of how Rustless Stainless Steel will respond to your shop operations is given in the "slide-rule" machinability chart available through the Rustless Iron & Steel Corp. Bulletin Bd-169.

Specialized Tester

The Rockwell superficial hardness tester is a specialized instrument for use where the indentation into the work must be kept shallow or of small area, yet sensitivity preserved. A supplement to Wilson Mechanical Instrument Co.'s catalog on the regular Rockwell tester tells all about it. Bulletin Sy-22.

Vacuum Cleaning

A very colorful brochure which illustrates modern cleaning methods by vacuum in industrial plants has been released by The Spencer Turbine Co. Bulletin Dc-70.

Heat Treat Chart

Heat treaters everywhere should find a heat treating wall chart complete with S.A.E. specifications a very valuable addition to their shops. Published by Chicago Flexible Shaft Co., manufacturers of Stewart industrial furnaces. Bulletin Ka-49.

Moisture Determination

A very colorful leaflet by the Harry W. Dietert Co. describes new, rapid methods of determining moisture content by drying. Illustrated. Bulletin Cd-198.

Air-Gas Proportioning

Proportional mixers for accurate Air-Gas proportioning are described in a catalog made available by the Eclipse Fuel Engineering Co. Bulletin Cd-226.

Metallographic Equipment

The large and complete line of equipment for the laboratory made by the Fisher Scientific Co. is described in a clever leaflet just released. Bulletin Cd-182.

Brazing

Economical brazing through the use of EASY-FLO is explained in a booklet released by Handy and Harman. Bulletin Cd-126.

Houghton Products

An attractive booklet summarizing the leading products which E. F. Houghton & Co. is supplying in volume to the metal industries of the world is now available. Bulletin Cd-38.

Combustion Safeguard

The Flame-otrol, a combustion safety device designed to shut off fuel and prevent explosions in case of flame failure, is described in a 12-page booklet by Wheelco Instruments Co. Bulletin Cd-110.

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Free Machining Steels

Speed Case and Speed Treat, two steels with increased machining properties, are described in literature available through Monarch Steel Co. Bulletin Cd-255.

Metal Blackout

The new JETAL process for blackening iron and steel quickly and thoroughly at low cost is described in literature available through the Alrose Chemical Co. Bulletin Cd-256.

Electric Salt Bath Furnaces

Users' reports on work treated in the Ajax-Hultgren salt bath furnace are described and operating data for cyaniding, carburizing, hardening high speed steel, etc., are given in literature of Ajax Electric Co., Inc. Bulletin Cd-43.

Insulating Firebrick

Just off the press—a new booklet gives engineering data on B & W K-16 Insulating Firebrick as manufactured by The Babcock & Wilcox Co. Bulletin Cd-75.

Correct Furnace Atmosphere

Furnace atmosphere can now be measured precisely by the improved ANALY-GRAPH which is described in a new booklet by The Brown Instrument Co. Bulletin Cd-3.

Heat-Corrosion Resisting

A handsome new 56-page book on electrical heat and corrosion resisting alloys containing general information and useful data about such alloys has just been published by the Driver-Harris Co. Bulletin Cd-19.

Hardening Furnace

A new pamphlet which describes "Certain Curtain" furnaces made by C. I. Hayes, Inc., will be particularly interesting to those with hardening problems. Bulletin Nc-15.

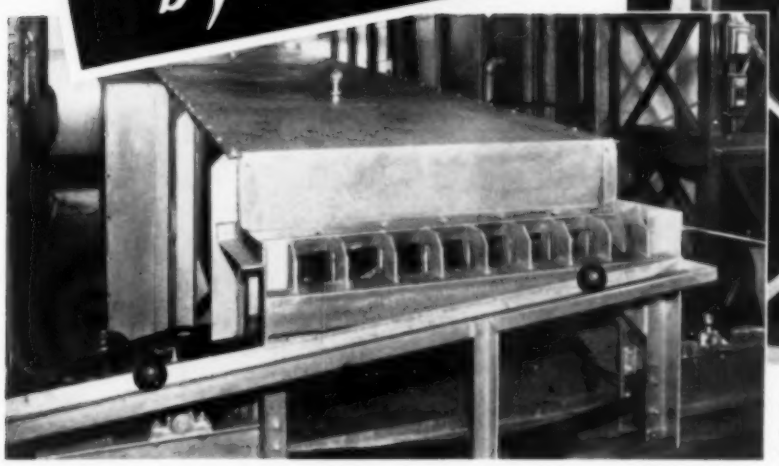
Low-Alloy Steel

A new folder on Mayari R, Bethlehem's high-strength, corrosion resisting steel, is colorfully illustrated with views of its various uses. Bulletin Kc-76.

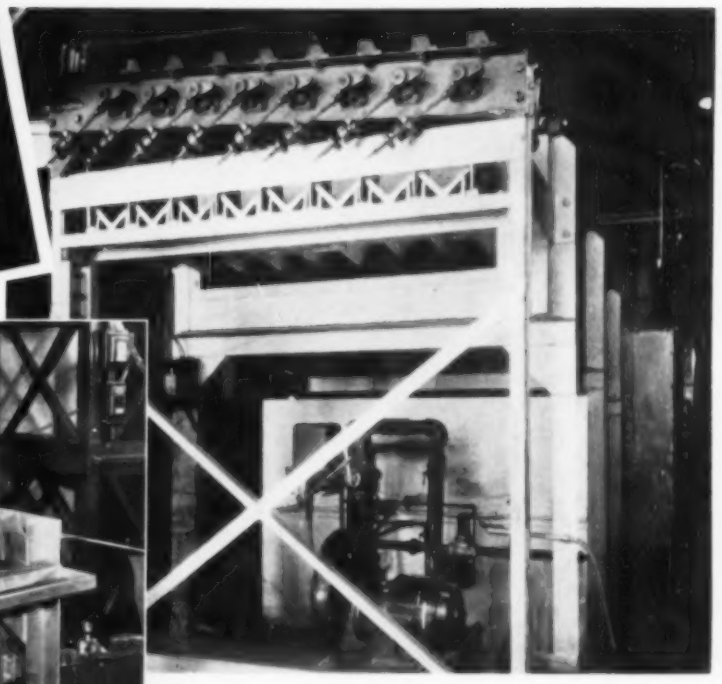
Bright Annealing

Various types of electric and fuel-fired furnaces built by the Electric Furnace Co. for bright-annealing wire, tubing, strip and other products are described in an 8-page folder. Bulletin Lb-30.

Another SPECIAL DESIGN by "SALEM"



This view shows charging end of furnace—portion of automatic feeding mechanism in evidence at top.



View at left shows discharge end of furnace—also automatically operated.

12 TONS of 5" BALLS per 8 HOURS
with SALEM fully automatic DRAWING FURNACE

This capacity is based on heating grinding balls from cold to 600° Fahr. Hearth capacity 460 5" balls; consequent heating time 2¾ hours. This furnace has an equivalent capacity when handling 3" balls of 7 tons per 8 hours. This furnace is of the recirculating type and is fired with fuel oil.

Elevator raises balls to top of charging end where they roll, one by one, by gravity through automatic closing, flap type doors. The last door closes a limit switch which repeats the cycle. Balls feed by gravity through the furnace. At discharge end a chain driven mechanism automatically discharges one ball at a time onto a gravity conveyor just outside the furnace.

Completely automatic, the simplicity of design and operation of this furnace is typical of "SALEM" Engineering which has solved many a difficult and unusual industrial heating problem.

The "SALEM" Engineering staff loves special or unusual problems, to which are applied sound engineering and building experience plus practical imagination to see new solutions. A qualified representative will be glad to consult with you on your problems.

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Tocco Process

The marvel of all heat treaters—the Tocco Process of Induction Hardening—is fully described in a colorful folder by the Ohio Crankshaft Co. Bulletin Lc-145.

Colmonoy

The high resistance to wear and corrosion which distinguishes Colmonoy alloys and overlay metals is explained in a 4-page catalog released by Wall-Colmonoy Corp. Bulletin Bc-85.

High Speed Steels

Seven grades of high speed steels are thoroughly described in an interesting folder released by Crucible Steel Co. of America. Bulletin Dc-56.

Fabricating Stainless

Fabricating Republic ENDURO Stainless Steels and other stainless steels is made easier in a booklet just issued by the Republic Steel Corp. Bulletin Hc-8.

Electrotinning

E. I. du Pont de Nemours & Co.'s manual on the sodium stannate-acetate electrotinning process is particularly timely. Electrodeposition, at first considered useful only for tin coating of recessed and irregularly shaped objects, is now being considered favorably for all types of work. Bulletin Ox-29.

Refinery Specialties

Refinery tube supports and other specialties made of Ohio Steel Foundry Co.'s "Fahrite" heat and corrosion resisting alloys are the subject of a well-illustrated loose-leaf booklet. Bulletin Ka-40.

Metal Heating

Improvements in furnace economies, operating conditions and appearance, furnaces that will more satisfactorily meet old requirements or handle new processes, service that will help solve the most stubborn problems are offered and described by Mahr Mfg. Co. in Bulletin Ea-5.

Carburizer

Modern is the furnace and modern is the catalog which describes it. Hevi Duty Electric Co. has an exceptionally well-written, well-illustrated, and artistically printed booklet on the Hevi Duty carburizer which uses the Carbonol process. Bulletin La-44.

Flame Hardening

The rapid development in recent years of the process of hardening with the oxy-acetylene flame well warrants the publication of this handsomely printed booklet which contains a multitude of excellent photographs of the applications of the process and of the equipment. Air Reduction Sales Co. Bulletin Ga-69.

Mounted Wheel Chart

A convenient ready reference wall chart showing mounted grinding wheels should be of great advantage in the cleaning room, pattern shop, tool and die room, and many other places. It gives at a glance, by means of detailed drawings, actual size, the exact radius of each wheel and its exact shape. Chicago Wheel & Mfg. Co. Bulletin Bd-230.

Microscope Accessories

A 62-page catalog with index and price list describes and illustrates all sorts of microscope accessories, including a wide variety of objectives and eye pieces, made by Bausch & Lomb Co. Bulletin Sx-35.

Continuous Heat Treating

Literature on their No. 29-F Heating Machine is now available through the American Gas Furnace Co. Shows picture of machine and gives operating data. Bulletin Bc-11.

Scale-Free Hardening

Complete information on equipment to assure precise heat treatment, eliminate scale, reduce costs, and improve working conditions is contained in a publication by General Electric Co. on conveyor-type electric furnaces for use with protective atmosphere for scale-free hardening. Bulletin Bb-60.

Bessemer Steel

Jones & Laughlin Steel Corp. has for distribution reprints of the paper by C. C. Henning on "Manufacture and Properties of Bessemer Steel" that received the Robert W. Hunt Award of the A.I.M.E. Bulletin Ca-50.

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Globar Elements

Globar Pin Type Non-Metallic Electric Heating Elements and Terminal Rods and Globar "AT" Type Non-Metallic Electric Heating Elements are explained and illustrated in two booklets issued by the Globar Division of the Carborundum Company. Bulletin Lb-25.

Furnace Experience

Facts developed through 32 years of engineering and building practically every type of industrial fuel equipment can be obtained through Flinn & Dreffein Co. Bulletin Bc-82.

Optical Pyro

No correction charts, accessories, nor upkeep are required with the Pyro optical pyrometer, which is a totally self-contained direct-reading precision instrument made by Pyrometer Instrument Co., and described in Bulletin Ay-37.

Forging Presses

Solid Frame Forging Presses having greater production possibilities are described in a new bulletin issued by the Ajax Manufacturing Company. Points out the wide variety of forgings capable of production on this type press. Bulletin Kb-105.

Vapocarb-Hump

Vapocarb-Hump, the triple-control method for heat treatment of steel, is described in a 36-page catalog issued by Leeds & Northrup Co., in which a special effort has been made to show how this method gives complete control of tool surface, shape and structure. Bulletin Cb-46.

Machining Data

A new chart giving the correct grade of Kennametal for machining 21 types of metals, with recommended cutting speeds, has just been made available by McKenna Metals Co. Bulletin Lc-238.

Low Cost Cleaner

A low cost speed-cleaning machine for plants having a rather limited production of small products is introduced in a folder by the American Foundry Equipment Co. Bulletin Ad-112.

Vanadium Steel

Latrobe Electrite Vanadium High Speed Tool Steel is described in literature released by the Latrobe Electric Steel Co. Bulletin Kb-208.

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★ The wide field at all magnifications is just one advantage of the B&L Wide Field Binocular Microscope. Other B&L features include the long working distance and the patented revolving Drum Nosepiece with paired objectives. These are features that mean *plus* usefulness in the laboratory or field.

The B&L Wide Field Binocular Microscope shows an erect, unreversed three dimensional image magnified up to 150x. Three types of stands adapt it to varying requirements. For full details write Bausch & Lomb Optical Co., 638 St. Paul Street, Rochester, N. Y.

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Portable Potentiometer

An extremely versatile indicating potentiometer with precise balancing, quick standardization, and easy-reading scales is described and illustrated in a folder by the Foxboro Co. Bulletin Nc-21.

High Speed Steel

Required hardness and extraordinary toughness combine to make Firth-Sterling Co. new high speed steel "Mo-Chip" of unusual interest to manufacturers who need a steel that is "practically indestructible." Bulletin Ad-177.

Electric Furnaces

A new catalog on electric furnaces and pyrometers has been released by the Hoskins Manufacturing Company. For anyone who does any kind of heat-treating, brazing, or uses heat-resisting castings. Bulletin Hc-24.

Laboratory Furnace

The Sentry Co. describes a high temperature tube combustion furnace. It permits operating temperatures up to 2500° F., thus offering greater speed and precision for combustion analysis or other laboratory procedures. Bulletin My-114.

Chapmanizing

Chapmanizing, the method of surface hardening steel with nitrogen, is described in a very attractive booklet of Chapman Valve Mfg. Co. Information is given on the method itself and on its metallurgical advantages. Bulletin Ob-80.

Welding Stainless Steels

A 24-page technical bulletin, giving important information for the engineer, designer or welding operator on the welding of stainless steel, is available through the Arcos Corp. Bulletin Hc-191.

Cr-Ni-Mo Steels

A. Finkl & Sons' catalog is really a technical treatise on chromium-nickel-molybdenum steels for forgings. Pocket size, 104 pages, cloth bound, illustrated by photographs, charts and tables. Bulletin La-23.

General Data Book

Valuable reference and data are contained in a book by Joseph T. Ryerson & Son, Inc., which gives metallurgical definitions, heat, hardness, and numerical equivalent tables as well as many valuable operating facts. Bulletin Nc-106.

Ni-Cr Castings

Compositions, properties, and uses of the high nickel-chromium castings made by The Electro Alloys Co. for heat, corrosion and abrasion resistance are concisely stated in a handy illustrated booklet. Bulletin Fx-32.

Fatigue Test

A complete description of the fatigue test as made on the R. R. Moore fatigue testing machine is given in a folder by Baldwin-Southwark Corp. Examples are discussed and illustrated. Bulletin Ka-67.

Oil Burners

North American Mfg. Co. offers a bulletin describing improved low pressure oil burners, one type especially designed for automatic control and ideally suited for use with proportioning control valves. Bulletin Na-138.

Park-Kase

A leaflet by Park Chemical Co. contains complete information concerning a new liquid carburizer of rapid and uniform penetration. Unique features and advantages of the bath are backed up with technical data. Bulletin Na-141.

Thermocouple Insulators

An exceedingly complete stock of thermocouple insulators is described in a bulletin made available by the Claud S. Gordon Co. Bulletin Hc-53.

Metallographic Reference

Nearly one thousand technical books and reference papers on Optical Principles in Metallography are listed in the new Metal Analyst just released by Adolph I. Buehler. Bulletin Lc-135.

Tempering

Vertical batch type tempering furnaces are described in a folder by Industrial Heating Equipment Co. Capacity and production figures and a diagram of the furnace are included along with a complete description. Bulletin Ia-168.

Multi-Point Pyrometer

The Alnor Rectangular Type Pyrometer, designed to provide a rugged moderately priced instrument with multi-point switch, is described in a release by the Illinois Testing Laboratories, Inc. Bulletin Dc-180.

Testing Machines

A compact spiral-bound 58-page booklet on the extensive Olsen line of testing machines and instruments has just been released by the Tinius Olsen Testing Machine Co. Well illustrated and filled with informative charts and testing data. Bulletin Gb-147.

Pot Furnaces

Cylindrical type Pot Furnaces for Lead, Salt, and Cyanide baths are illustrated and described in a leaflet issued by the American Electric Furnace Company. These furnaces are adapted for practically any heat treating operations using a liquid medium. Bulletin Kb-2.

Hydrogen Brazing

A new "Electroblast" hydrogen brazing furnace designed for the inexpensive, clean brazing of carbide-tipped tools is described in a folder by Stark Tool Co. A full description of the method of brazing and precautions necessary is included. Bulletin Ab-186.

Lubrication

Intensive research which completed important improvements in the field of heavy-duty gear and bearing lubrication is tabulated in a new 12-page illustrated bulletin just released by D. A. Stuart Oil Co., Ltd. Bulletin Lb-118.

Metal Progress, 7301 Euclid Avenue, Cleveland, O.

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